MACHINERY.

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THE SHOPS OF THE BETHLEHEM STEEL COMPANY.

ILLUSTRATIONS AND DESCRIPTIONS OF SOME OF THE NOTABLE TOOLS USED FOR MACHINING THE FORGINGS MADE AT THESE WORKS.

Of no less interest than the production of steel forgings at the plant of the Bethlehem Steel Company, as described in the last number of the paper, is the machining of such forgings in the extensive shops of these works.

On this page is shown a general view of machine shop No. 2, where the bulk of the work is machining forgings for guns and such general forgings as large shafts and other engine and machine parts. Complete guns and gun carriages are manufactured here, ranging in size from the 12-inch "peace-maker" to the 4-inch rapid-fire gun which did such terrible execution at Santiago. Work of this character, together with the general machine work that a large firm inevitably has to do, is sufficient to require a shop building over a quarter of a mile long and over 117 feet wide, probably the largest shop building in the world, and the exact dimensions of which are given in the caption under the illustration. In this shop has been done such large work as the machining of the forgings and castings for the 125-ton hammer owned by this company, the most powerful hammer ever made, and the top and bottom heads of the hydraulic press shown on page 35 of the last number, weighing 135 and 120 tons respectively, besides other heavy presses and tools of phenomenal sizes. The shop methods, tools and machinery to be seen here present many attractions to the man of the machine shop; but still more unusual, and for that reason of still greater interest to the average mechanic, is the machining of the forgings for armor-plate, which is done in machine shop "No. 3." This building, although smaller than the other one, is 775 feet long and 120 feet wide in the main portion. The equipment is entirely of massive machinery, of a kind that is seldom seen, most of it having been either imported from the Creusot works of France, or made by the Bethlehem Steel Company themselves. The writer was shown one plate for the front of one of the turrets of the Alabama that measured 20½ x 11½ feet and was 14 inches thick. This is one of the largest plates ever made, and indicates the capacity of the plant better than any description that could be given.

Fig. 1. Main machine shop of the Bethlehem Steel Company. It is 1375 feet long, 117 feet, six inches wide and is probably the longest single shop building in existence. The central span is served by six traveling cranes ranging from 75 tons to 25 tons capacity, and the wings by four traveling cranes. Here are located the tools and appliances necessary for machining the forgings for the heavy guns, engine shafts and other machine parts, as well as for turning out other lines of work of the most massive character.

The Main Shop.

The main machine shop, which is shown in the illustration, is of steel construction and is built with one central span and two wings, one on each side. The central span is 60 feet wide, and short lengths of shafting are supported by the columns on each side and are driven by six 12 and 24 by 24 compound engines,

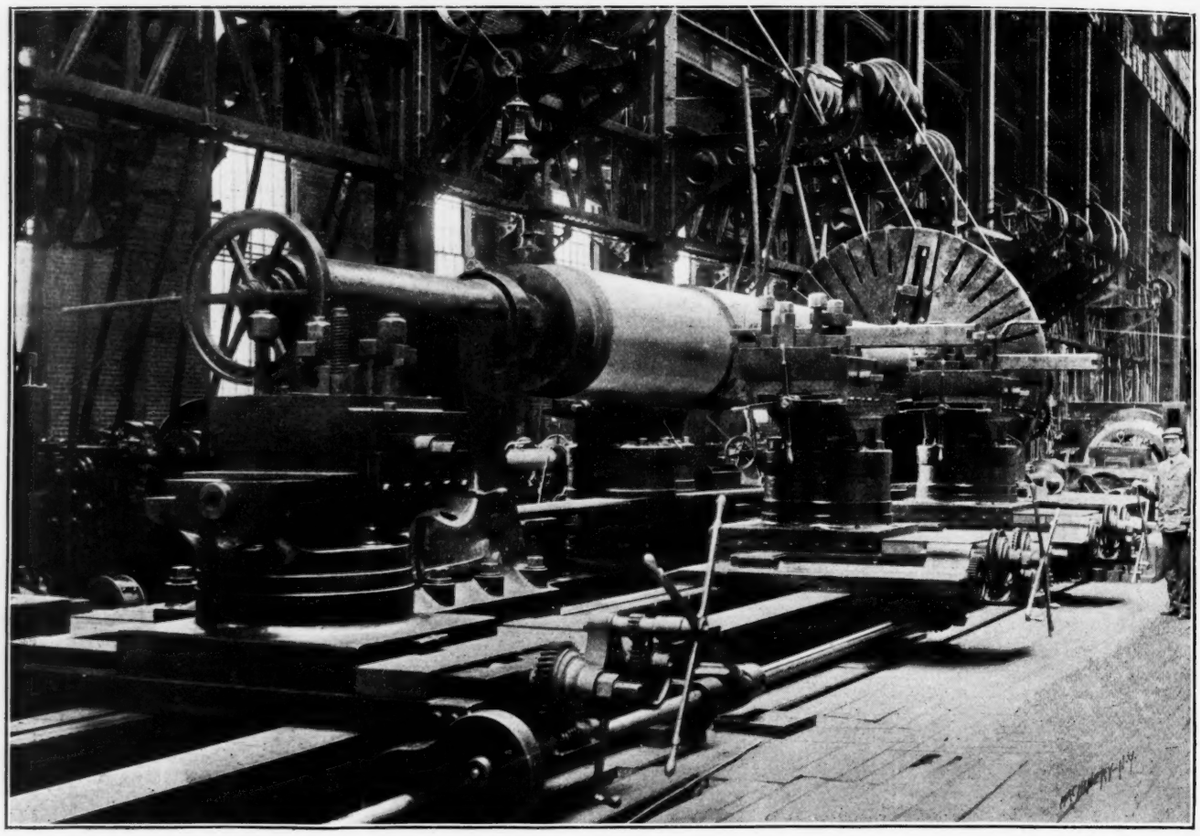

Fig. 2. Screw-cutting engine lathe in "machine shop No. 2," for turning heavy guns and shafts. Face plate 120 inches in diameter and swing over shears 130 inches by 76 feet. It is geared for turning taper from one in ten to one in 400, and there are four carriages with compound rests. Besides this lathe there are five in the shop, with 120-inch face plates and of 100-inch swing. The shaft shown in the lathe weighs 65,000 pounds and is 37 inches diameter at the center and 27 feet 4 inches long.

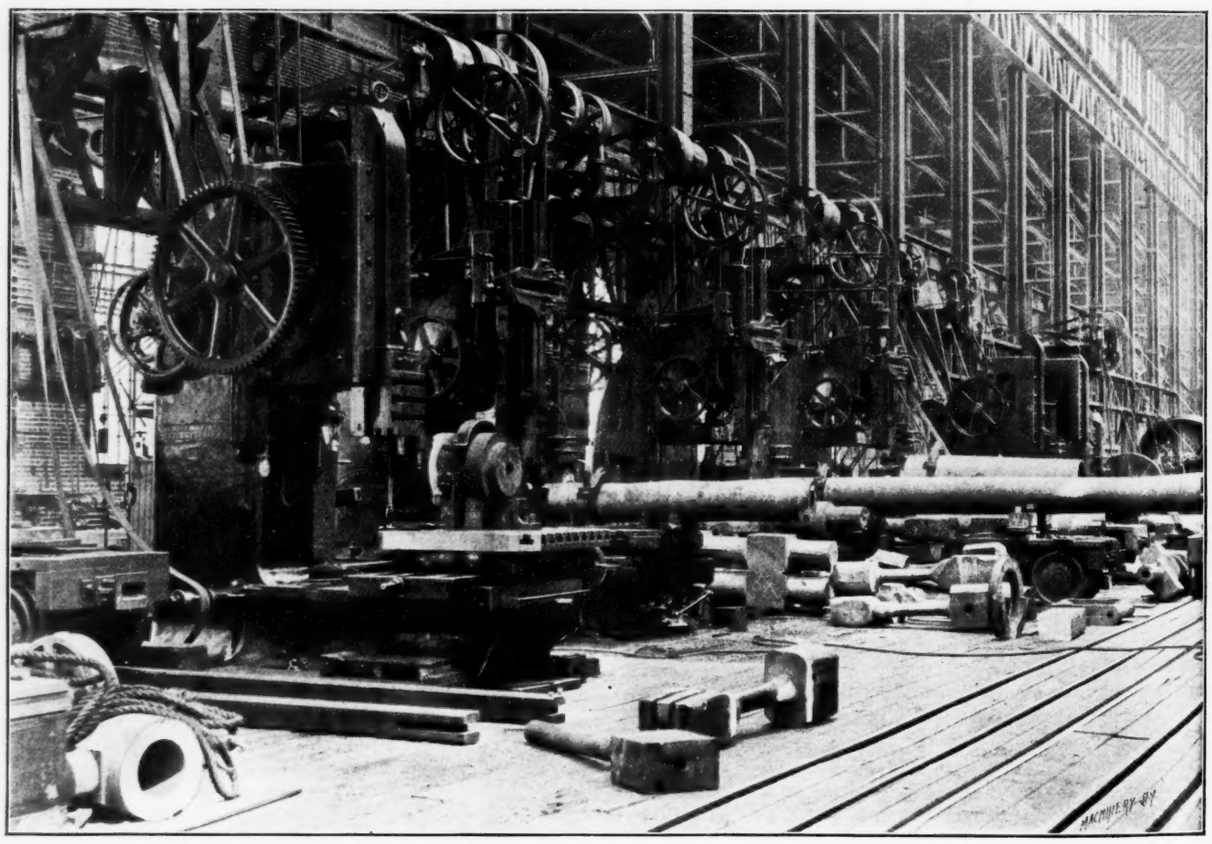

Fig. 3. Row of 60-inch slotters. In machining forgings such as connecting-rods and cranks, in cutting out test pieces and squaring up the ends of forgings, the slotter is a necessary tool. There are five of them in the row shown and on the other side of the shop are six more of 36-inch stroke. All of these are kept busy and make a remarkable collection of machines.

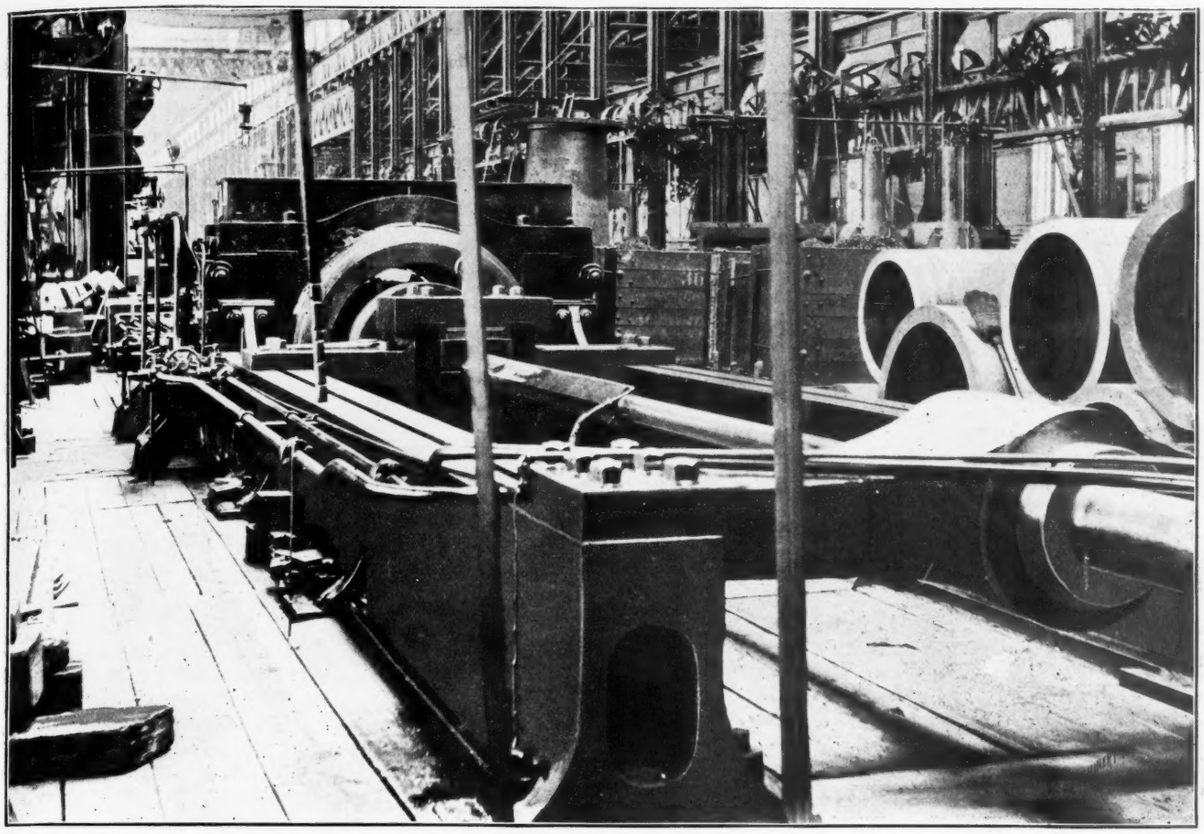

Fig. 4. Ingot boring mill, with hydraulic feed. The driving head is in the center and there are two boring bars, one at each end. With this machine a hole can be bored 25 feet long. The head will take work 54 inches in diameter and a hole can be bored 20 inches in diameter, from the solid, by starting with a flat drill and finishing with inserted cutters.

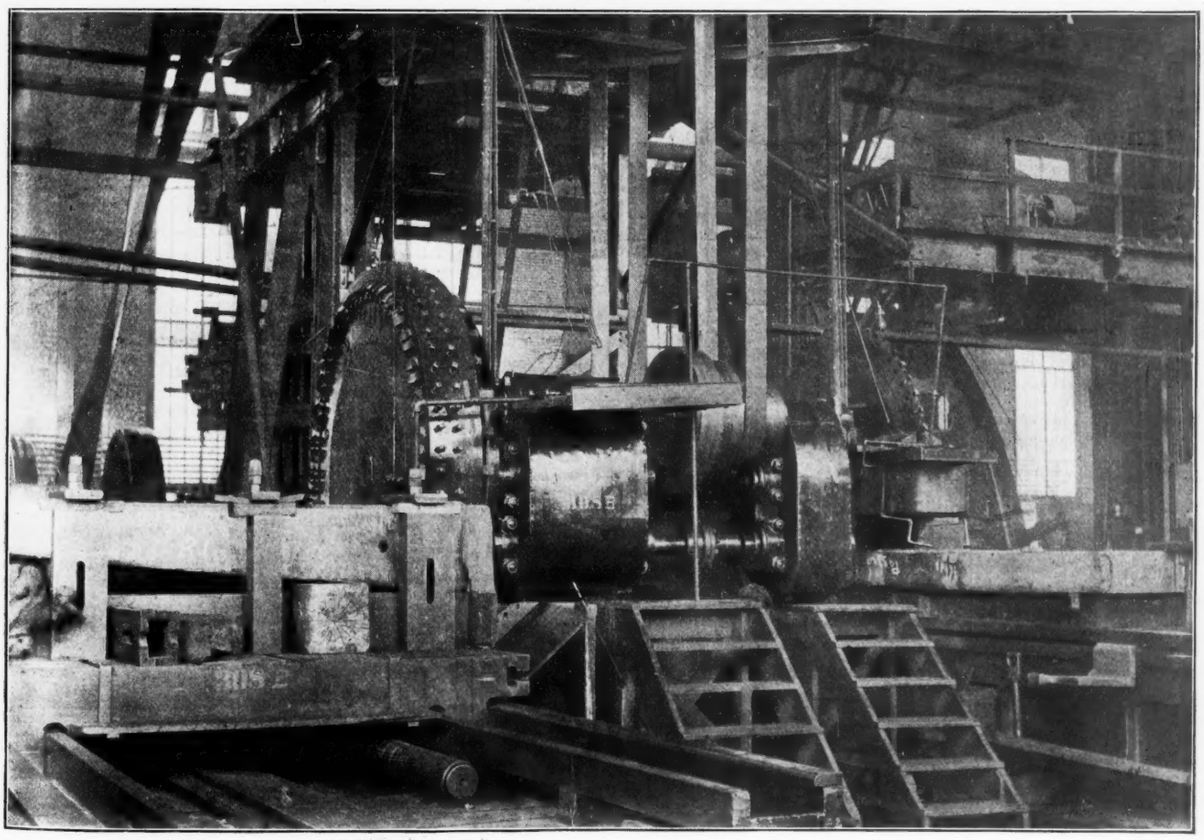

Fig. 5. Rotary planer and saw, operating upon armor plate. The cutter-head and saw are 84 inches in diameter and the tables have a travel of over 30 feet. This powerful machine was built at the Bethlehem works for the heaviest class of armor-plate work, up to 30 inches thick.

ranged at intervals down the shop. There are three lines of track running through the shop, one of standard gauge for freight cars and two of narrow gauge for shop cars. The main part of the shop is served by six travelling cranes of from 25 to 75 tons capacity, four of which are electric and the other two are pneumatic, but are to be converted into electric cranes.

Those who have seen the forgings furnished by the Bethlehem Steel Company to firms in different parts of the country know that they are received "rough turned," or with the bulk of the surplus stock removed, leaving the piece so that it at least resembles the shape that it will have when finished, which is not always the case with forgings in the rough state. All of this roughing is done in this shop, and it would be an eye-opener to most mechanics who have attempted to work high carbon steel, and especially gun steel, to see with what ease and speed the mechanics here succeed in peeling off the chips. It is our impression that the speeds used are fully 50 per cent. higher than we have seen elsewhere on similar work, and it is due, no doubt, to three causes. First, the machine tools are heavy enough to stand up to the work; second, a long series of experiments has been conducted to determine what brands of tool steel are exactly adapted to the requirements; and third, soda water is used freely, the tools being flooded with it. An extensive soda water system is now being installed, with a view to having this lubricant easily accessible at any point of the shop. Cement flooring is being put down, draining toward the center of each machine, from which points the soda water is conducted to central tanks. It is also arranged so that any overflow will run toward the center of the shop, where it will drain to the tanks. Pipe lines are being put in, with suitable connections to the different machines, and the supply is kept up by pumps which draw from the central tanks. This system is the most complete and elaborate of its kind that we have heard of, and it could be adopted on a smaller scale by many shops with profit. It would increase the speeds and feeds enough to pay a good interest on the investment, if, indeed, the first cost were not wiped out within a short time.

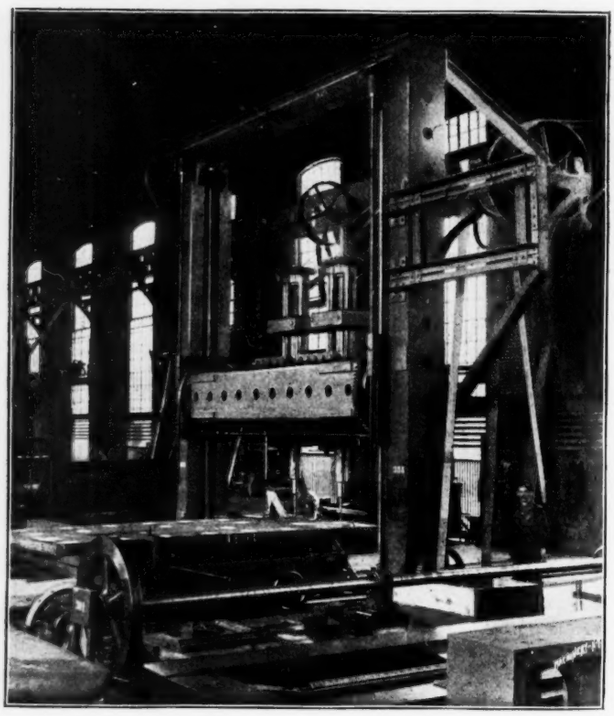

Fig. 9. Bement, Miles & Co. double drill press. There are five of these machines that are capable of drilling or boring in any direction in any plane. The table also has a feed so that the machine can be used for milling. Two of the machines have a capacity of 17 x 20 feet, one a capacity of 14 x 17 feet and two of 14 x 14 feet. The dimensions can be best appreciated by comparing with the machinist standing at one side.

Besides roughing out forgings for other companies to finish, this company finishes hundreds of forgings that are too large or complicated for other shops to handle efficiently. Since open-hearth fluid-compressed steel has been available for engineering work, the demand for it has grown steadily, and engine builders and others place orders for shafts, connecting-rods and other parts to be forged and made here complete, ready for shipment to the point where the plant is to be erected. The extent to which this is done is one of the decidedly modern innovations of engineering, and shows to what an extent specialization is being carried. Shafts ranging from those for ocean liners to those for torpedo-boats and yachts are made, and as great a variety of other pieces. Some of these smaller quadruple throw crank shafts with cranks, crank pins, eccentrics and shafts forged in one piece, and with pins and shafts hollow, are as handsome pieces of machine work as one could wish to see. One of these, for example, was of steel of 60,000 pounds elastic limit, 5 inches outside diameter and 3½ inches inside diameter.

In turning these shafts the method is adopted of facing the flanges, with the shafts turning in regular bearings set up on the lathe ways, so that they rotate under normal conditions and the facing will come true with the axis of the shaft. Aside from the other advantages of hollow shafts and crank pins, this feature is of advantage in turning the pins of such shafts, since a bar can be run through one of the hollow pins, and, by suitable centering blocks at the ends, the shaft supported very nicely on the bar, which is then placed between centers.

Boring Long Holes.

Perhaps as interesting work as any that is done in the shop is boring out the centers of the solid ingots, from which shafting, gun-hoops and other hollow forgings are made; and also the boring of shafting and other long pieces. One of the machines for boring, or more properly, for drilling ingots, is shown in Fig. 4. The boring head is of a very simple character, consisting of a two-bladed cutter inserted in the end of the bar—in reality, nothing more nor less than a modification of the old-fashioned flat drill. The edges of the drill are grooved to break up the chips, and back of the cutter, teeth are inserted in the bar to bore out the hole started by a drill to a larger size. To drill a 5- or 6-inch hole through a steel ingot several feet long, at the same time boring out the hole to a still larger size as the drill progresses, and to have these operations going on at the two ends of an ingot simultaneously, requires a degree of rigidity that is seldom found, and a power and evenness of feed that can be obtained only by hydraulic pressure. The degree of feed is regulated by varying the hydraulic pressure through the medium of a by-pass.

There are in all nine large boring machines in the shop for boring long holes in pieces ranging from 54 inches in diameter down to smaller sizes. There are also three small Pratt and Whitney machines for boring holes through small shafts, spindles, molds for printers' rollers, etc. These twelve machines are in addition to five gun lathes, for 12-, 10-, 8- and 5-inch guns, which are fitted for both boring and drilling. It is claimed that a hole 60 feet long, such as might be required in a marine engine shaft, can be bored and finished true within small limits, the holes being drilled thirty feet from each end and meeting with no appreciable shoulder after the finishing cut has been taken. This may seem incredible, but it must be remembered that the material operated upon is of uniform texture throughout and that a "hog bit" is used, which experience has demonstrated will do remarkable work if there are no blow-holes or irregularities of the material to throw it out of its course.

Large Tools.

The pit planers in use here, one of which is shown in Fig. 6, possess features that make them valuable tools for extremely heavy work, where the mass is so great that it would preclude having the work itself move and the tool stationary. The planer in the main shop has a capacity of 10 by 14 feet through the uprights and will plane 30 feet long. The pit itself is 12 feet 9 inches by 44 feet and 14 feet deep. The planer was built at these works to machine the parts of the large hammer referred to and the large forging and bending presses described in the last number. At present it is used for any of the larger work, such as planing the frames of the carriages for coast-defense guns.

While speaking of large planers it will be of interest to state that they are now building for the armor-plate shop a so-called "cross-cut" planer that will take at one time plates having an aggregate surface of 20 by 30 feet. The foundation for this machine is 40 by 56 feet.

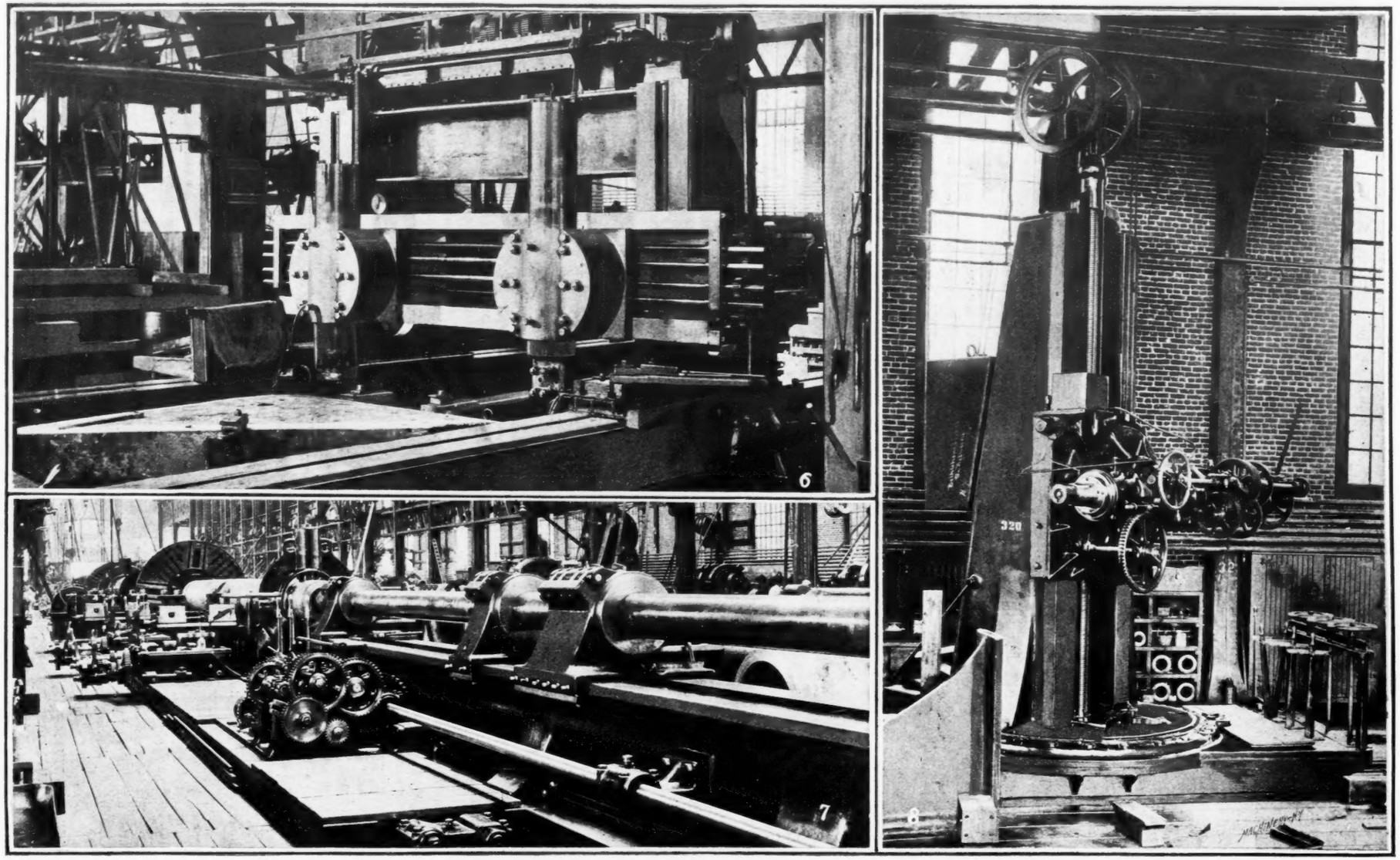

Fig. 6. Pit planer in armor plate shop. There are two of these planers, with a capacity of 10 x 10 x 30 feet, and in the main machine shop is one of still larger size. The work remains stationary and the cross rail and uprights are driven by two longitudinal screws, one at each side, and slide upon the ways shown at the sides of the planer.

Fig. 7. Twelve-inch gun lathe in the machine shop, for boring and turning the coast defense guns. The traverse and feeds of the carriage and the feeds of the boring bar are all operated by handles and levers. In turning work the operator rides on a platform attached to the carriage and has every motion at his command through these levers.

Fig. 8. Bement, Miles & Co. milling machine in Shop "No. 3." This is a universal machine for milling, boring and drilling and is used for finishing the edges of port holes in armor plates. The column swivels on the base and the head swivels on the saddle. The vertical travel on column is ten feet and the horizontal travel on bed plate 30 feet.

As a matter of record, we will state that the longest lathe in the shop will take 80 feet between centers, the longest boring machine will bore a hole 60 feet long, and the largest lathe and drill are described sufficiently in connection with the illustrations 2 and 9.

In the Armor-plate Shop.

When an armor-plate has been finally treated, its face is so hard that it is impossible to drill or otherwise machine it by any ordinary means. Such work must be done before this final treatment takes place, and so these plates are first brought to approximately the right size, and if any openings, such as port-holes, are required, these are drilled out previous to the hardening. After hardening, the backs of the plates are still soft enough to be worked, and the edges at the back can be milled down to the exact dimensions to within a few inches of the outer face, and then this remaining face must be ground off. The grinding machine, therefore, plays an important part in the manufacture of armor-plate, and is even more necessary here than in ordinary shop practice, where it is now generally termed a necessity. There are five grinding machines in the armor-plate shop of special design for this work.

The most striking tools in the armor-plate shop are the rotary saws, of which there are four, that trim the edges of the plates. These machines were imported from the Creusot works, France, and will saw a plate 24 inches thick and 33 feet long. The body of the saw is 84 inches in diameter and has 76 inserted cutters, which alternate wide and narrow to more readily break up the chips and prevent binding. Each saw is driven by a worm-wheel 90 inches in diameter.

The combined rotary planer and saw illustrated in Fig. 5 is a more powerful tool than the others, and was designed and built by the Bethlehem Steel Company. It has afforded a good opportunity to compare the merits of the rotary planer and the saw, and the capacity of the planer has been proven to be such that it will take off metal six inches deep from the edge of a plate 10 inches thick quicker than the saw will take off a strip of the same width and thickness. This is a remarkable machine and it is engaged steadily upon remarkable work.

Besides the grinding machines and the saws, there are in this shop two pit-planers like that illustrated in Fig. 6, the universal milling and drilling machine of Fig. 8, and three drills like those in Fig. 9. These illustrations give a clear idea of the character of the operations to be done upon armor-plate and of the character of the tools required.

The plates have to be planed, finished on their edges and any openings have to be drilled out. They are also drilled and tapped at the back for the standing bolts that fasten them to the framework of the ship. All plates are erected side by side in the shop in their relatively correct positions, just as any machine work would be, and to handle such massive weights requires ample crane capacity. A new use for armor-plates has recently been found in the construction of safe-deposit vaults. One was recently built here with a door having ground joints, and it was calculated that the kind of material that has been found efficacious in resisting an enemy's shots would be, at least, troublesome to an evil-minded person who was trying to get on the inside of the vault without the combination. This construction is vastly superior to composite-built vaults.

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HARDENING SOLUTION.

Of all the various receipts for hardening compounds, I have never really known of but one that was of any practical value.

A solution of chloride of sodium in water will make the water a much better conductor of heat and will therefore cool the piece off quicker. The result is that you get the steel much harder and at a lower heat than with clear water. There is also a slight chemical action which causes the scale to drop off, and the piece comes out of the bath considerably cleaner.

The chloride of sodium should be in a cloth bag, hung near the top of the tub, and the water will gradually take up a considerable quantity of it.

P. S.—The above is written for the benefit of those who are not satisfied unless they have something very mysterious and scientific. To those who are satisfied with the plain old common-sense rules, I would say that chloride of sodium is nothing more nor less than common salt.—"The Professor" in "Sparks from the Crescent Anvil."

WIRELESS TELEGRAPHY.

AN EXPLANATION OF THE PRINCIPLES OF THE SYSTEM USED BY MARCONI IN REPORTING THE RECENT RACES FOR THE AMERICA'S CUP.

WM. BAXTER, JR.

Wireless telegraphy is looked upon by the popular mind as the greatest of all electrical mysteries, and, further, it is believed to be an achievement realized only within the past few months. As a matter of fact, the action is not in the least mysterious, and can be readily understood by any one when explained in simple language; and it is not an entirely new development. There are three ways known, at present, in which wireless telegraphy may be accomplished, but in this explanation we will confine ourselves to the system used by Marconi, which is the one that has been brought to the highest state of perfection, and, in fact, the only one that can be said to be commercially successful. Wireless telegraphy has been experimented with for many years, but it was not until about fifteen years ago that any practical results were obtained. In 1884 messages were sent through underground wires, were read upon telephonic circuits located eighty feet above them, and in the following year speech by telephone was carried on over a distance of about one mile and a quarter. In 1892 messages were transmitted over a distance of more than three miles. Marconi's experiments began in 1896, and up to the present time he has succeeded in transmitting messages to a distance of about 30 miles. Most of the apparatus used by Marconi is old and was invented by others, nevertheless he has obtained results far greater than any one else, and the difference appears to be due to the addition of a vertical wire, varying in length from 20 to 100 feet or more, according to the distance to be covered. Thus, it will be seen that in this case the difference between small and great results depends upon a very small thing—a few feet of wire—but this does not in any way detract from the credit due to the inventor for having obtained results far greater than any of his predecessors; in fact, the simplicity should only add to the credit he is entitled to.

In order that the principles of wireless telegraphy may be understood, it is necessary to disabuse the mind of the popular notion with respect to the nature of electricity, for, so long as this remains, a correct insight of the subject cannot be obtained. Electricity is generally regarded as a mysterious fluid that possesses the power of flowing at an enormous velocity and in great quantities through wires, just as water flows through pipes. When a man looks at a trolley car running along the street at a high rate of speed he pictures in his mind's eye a tremendous amount of electric fluid flowing through the trolley wire from the generator in the power station to the motors under the car. He can hardly realize how this incomprehensible fluid can travel along the wire without producing any noticeable effects, but he sees the car and the trolley wire, and knows that the power that moves the former comes from the distant power house and comes over the wire; hence, although he cannot see how the fluid gets through, he knows that it gets there. When he tries to unravel the mysteries of wireless telegraphy by the same process of reasoning he becomes hopelessly entangled, for he cannot understand in what way the mysterious fluid can cut through space from the sending to the receiving station; he wonders why the fluid will not go in the opposite direction, or in any other direction just as well. The first step to take to remove all confusion is to understand that electricity is not a fluid, that it is not a material thing, but simply a force of nature that is made manifest whenever the minute particles of matter are set in motion in a certain way. In other words, electricity is a force which is the result of a certain form of motion.

It is difficult to understand at a first glance how a form of motion can account for the transferences of hundreds and even thousands of horse-power over long distances, but such an action can be readily illustrated. Suppose we have a trough ten feet long, and say five inches wide and of equal depth and filled with water. If we agitate the water at one end with a paddle we will produce waves that will travel to the other end. If at the distant end we place a float, it will rise and fall with the waves as they roll in from the sending end, and if the float is connected with the plunger of a pump, it will move the latter and thus pump water. Here we have a simple illustration of the

manner in which the wave motion imparted to the water by the paddle at one end will cause a float to bob up and down at the other end of the trough and thus operate a pump; hence, we have a transference of the power applied from the paddle at one end to the pump at the other end, and all accomplished by the wave motion imparted to the water. If the trough is made two or three hundred feet long and correspondingly wide, and the water is agitated by a sufficiently powerful paddle, a pump of large size can be operated at the distant end. Now, if power can be transferred from one end of the trough to the other by means of the wave motion imparted to the water, why cannot the same result be accomplished by propagating a wave motion through or along a wire connecting an electric generator with an electric motor? The modern theory of electricity says that it can, and this is the way in which energy is transferred in an electric conductor. Light, according to the modern theory, is also produced by wave motion, but the waves are very short, being, in fact, of microscopic dimensions.

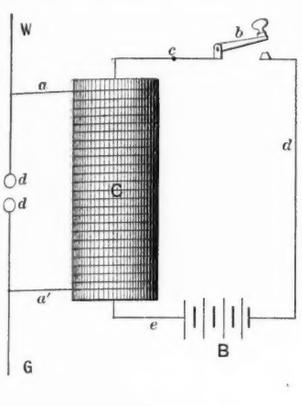


FIG. 1.

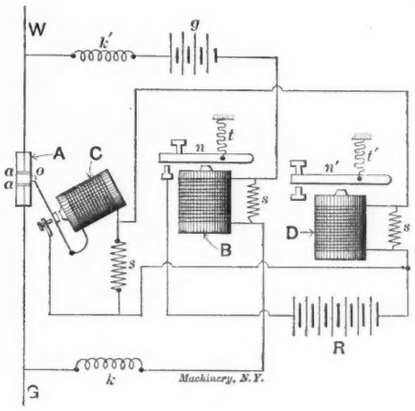


FIG. 2.

About thirty years ago, Prof. Clark Maxwell advanced the theory that light and electricity are of the same nature, and that the only difference between them is in the length of the waves. About ten years ago Prof. Hertz proved experimentally that Maxwell's theory was correct, this proof consisting in the production of an apparatus, called a Hertz oscillator, which develops electric waves that radiate into space in precisely the same way that light rays do. The rays of light emitted by a lamp can be seen by the human eye, because the latter is so constructed that it is affected by light radiations, but the eye cannot see the electric rays emitted from a Hertz oscillator simply because it is not so constructed as to be affected by them. Telegraphing through space by means of powerful lights would not be considered anything wonderful, because the eye can see the light if there is no obstruction in line with it. Now, to telegraph through space with electricity, all we have to do is to provide a Hertz oscillator to develop the electrical radiation at one station, and a device capable of detecting this radiation at the other station. In other words, the sending instrument at one station must be so made as to produce an electric radiation, and the receiving instrument at the other station must be so made as to see this radiation—that is, it must be an electric eye.

The way in which all this is accomplished in the Marconi system can be explained in connection with the diagrams Figs. 1, 2 and 3. Fig. 1 shows the transmitting instrument. C is an induction coil, the same in construction as those used in medical batteries to give shocks, but very much more powerful. An induction coil, it may be well to state, is a device employed to obtain, by means of a current of low pressure, another one of very high pressure. The low-pressure current used is of large quantity and may be compared to a large stream of water moving with a small velocity, while the high-pressure current is of very small quantity, and can be compared to a very small stream of water flowing through a small pipe, but with a very high velocity. The low-pressure current is called the primary, and the high-pressure current is called the secondary. The coil is wound with two separate wires, one for the primary and one for the secondary; the primary coil is made of large wire—say No. 16—and has a small number of turns, generally about as many as will go in two layers. The secondary coil is made of fine wire, about as thick as a hair, and consists of many thousand turns. In Fig. 1 the ends of the primary are connected with the wires c and e, which form part of a circuit in which are located a battery B and a telegraph key b. When the key b is depressed the circuit is closed and a current flows through the primary coil wound on C. This primary current induces a secondary current in the fine wire coil, wound on C, and this current passes by wires a a to wires W and G. The latter wire is connected with the ground and W is connected with a wire that runs vertically up into the air along a supporting pole. The wires G and W terminate in two metallic balls d d, which are placed about one-half of an inch apart. When the key b is depressed, the secondary current induced in the induction coil C passes to the wires G and W, and not finding an outlet through the ends of these, jumps across the space between the balls d d. In consequence of this action the wire W becomes a center from which electrical radiations emanate, and as the upper end is high above surrounding objects the rays can reach to a considerable distance in every direction. If at any point within the range of the radiation an electric eye, or receiving instrument, is placed, it will see the radiation. So long as the key b is held in the depressed position the wire W will emit rays, but these will disappear the instant the key is raised. From this it will be seen that by depressing b at proper intervals and for suitable lengths of time, signals can be transmitted that can be readily detected at the receiving station.

The instrument at the receiving station is illustrated diagramatically in Fig. 2, and the important part of it, that is, the electric eye, is shown on an enlarged scale in Fig. 3. The wires G and W are arranged in this instrument in the same way as in the transmitter—that is, G is connected to the ground and W is run up a high mast. The balls d d of Fig. 1 are replaced by the tube A. As will be seen, the wire leading from W passes through k', which is an inductive resistance, thence through a battery g, a magnet B, and another inductive resistance k, and then taps wire G. The tube A, as clearly shown in Fig. 3, holds two wires with flanged heads. These heads are some distance apart and the space between them is filled, loosely, with metal filings. These filings when in the normal state offer a very high resistance to the passage of an electric current, but after a current has been established, the resistance falls down to nearly nothing. The battery g cannot force a current through A, in Fig. 2, as the pressure of the current it generates is not sufficient for the purpose, but when the electric radiation from the sending station strikes the wire W it induces therein a current of very high pressure and this is capable of breaking through the resistance of A. As soon as this high-pressure current passes through A the resistance drops down to practically nothing, and then the current from the battery g follows up. This battery

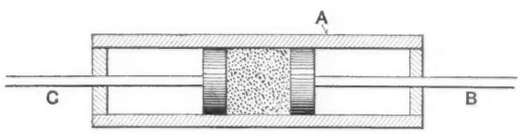


FIG 3.

current passes through the magnet B and causes the latter to attract the lever n and thus the circuit, in which the battery r is located, is closed. This circuit contains the magnets C and D; the first one acts to vibrate the lever upon the end of which is located the knob o, and the second one actuates the sounder key n'. The tube A, if not disturbed after it has been traversed by an electric current, will remain of low resistance, but it would not do to have it act in this way, for then the current of the battery g would continue to flow and the sounder D would keep up a continuous rattle If, however, the tube A is rapped gently after the current has passed through it, it returns to its natural state, in which, as we have said, its resistance is very great. It is on this account that the striker o is provided. This is operated by the magnet C and is so adjusted that it strikes the tube every time the current passes through it; therefore the battery g can-

not send a current through the circuit except while the current induced in the wire W by the radiation from the sending station, is passing. The tube A is called a coherer, but it is also referred to as an electric eye. It is made of glass and is about one inch and a half long and about one-eighth of an inch inside diameter.

The magnet D can be dispensed with if it is not desired to record the signals on paper, for the vibrator o acts as a sounder and the signals given by it could be easily read by a telegraph operator. In the Marconi system the messages are marked down on paper, in dots and dashes, after the fashion of the Morse instruments of days gone by, but if wireless telegraphy becomes common it is more than probable that the sound system used in regular telegraphy will be adopted.

From the foregoing explanation it will be seen that there is nothing mysterious about the operation of wireless telegraphy; it simply consists in using, for a sending instrument, a device that is capable of emitting electrical radiations, and for the receiving instrument a device that is acted upon by these radiations.

The possibilities of wireless telegraphy have been greatly exaggerated by the sensational press. It has been asserted that it would supersede the present methods and that before long messages would be transmitted across the Atlantic and that many other impossible things would be done. As a matter of fact, however, wireless telegraphy is limited to a certain sphere. A light located upon a prominence can be seen by any one within range of it, no matter on what side he may be located, and so with wireless telegraphy; any receiving instrument placed within the range of the transmitter can receive the signals; hence there could be no privacy with it, as an unlimited number of stations could be located so as to receive the message from a given transmitting point. From this it can be seen at once that if ten or fifteen transmitting stations were located within range of each other and within range of several receiving stations, there would be an endless confusion, as each receiver would be acted upon by several transmitters at the same time. It has been proposed to get around this difficulty, in a measure, by using reflectors and focusing the rays in the same manner as the light rays are focused with search-light projectors on board ship, but, so far, it has been found that when reflectors are used, the distance to which the signals can be transmitted is reduced to about four or five miles, so that by this expedient privacy is obtained at the reduction of distance. When reflectors are used the wires W and G are discarded, and the reflectors are placed back of the balls d d, in the transmitter, and back of the coherer A in the receiver. The two instruments are then placed at a considerable elevation so as to be within each other's range when located at the points desired.

It has been asserted by some writers that wireless telegraphy can only be made to operate between points that are in sight of each other, and that on that account the vertical wires W would have to be made of sufficient length to compensate for the curvature of the earth. The experiments of Marconi, however, prove that this conclusion is not correct, as in several instances he has maintained communication between points that were hidden from each other by intervening hills, and, in at least one instance, the distance between the stations was such, relatively to the height of the wires, that the curvature of the earth placed the stations out of sight of each other, and the electrical rays, if they passed in straight lines, must have pierced the surface of the earth. According to Marconi's practice, the wires W are made twenty feet high for a transmission to a distance of one mile, and for greater distances the distance is increased as the square of the height of the wire, so that with a wire 40 feet high the distance between stations can be four miles, and with wires 80 feet high the distance can be 16 miles, while with wires 160 feet high the stations could be 64 miles apart.

* * *

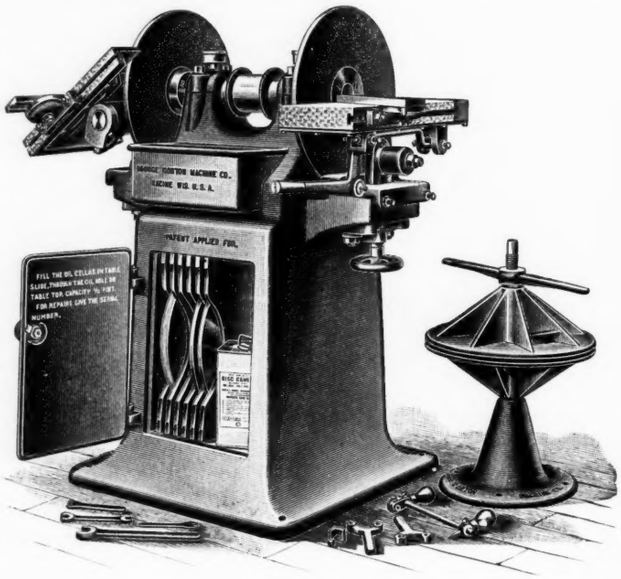
It is evident that the gospel of plenty of light in machine shops cannot be preached too strongly when one notes the many shops throughout the country in which the small amount of light that struggles through the dirty windows is almost entirely absorbed by the grimy walls and ceilings. Plenty of light encourages industry, enables accuracy to be attained, and promotes the efficiency of the entire shop.

UNIVERSAL DISC GRINDER.

We have previously called attention in these columns to the advantages which disc grinders having smooth metal discs, covered with emery cloth cemented to their faces, possess for a great variety of work.

Comparatively few years ago it was considered essential that all the finished parts of machines should be filed and rubbed down by hand, and while this process produced superior results, it was the most expensive work put on the machine and at points where expense was entirely unnecessary. Later, buffing and polishing wheels and straps came into use and greatly reduced the cost of polishing, but had the objection that they would not produce true and even work.

The disc grinder is designed for the rapid finishing of metals, the intention being to produce the work with the speed of the ordinary grinder, but with the accuracy of hand and machine work. The emery, being backed by the true and hard surface of the metal disc, presents an accurate surface for shaping the work, and, as there is no glazing or grooving of the surface, as with the ordinary wheel, it makes a free cutting grinder. When a sheet of emery is worn out it is simply stripped off the disc and a new sheet cemented on.

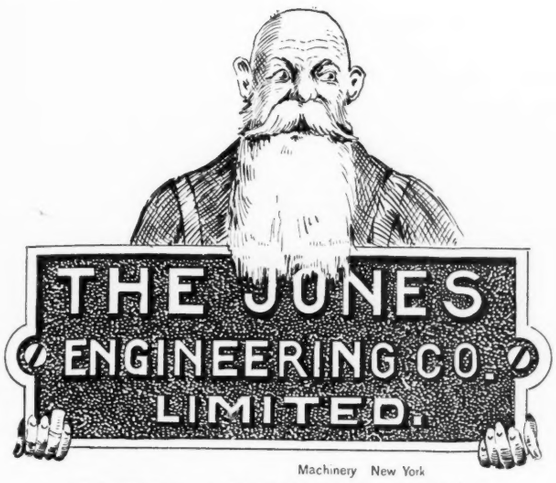


GORTON GRINDER

In the accompanying illustration is shown the latest style of disc grinder, as made by the George Gorton Machine Company, Racine Wis., which possesses some new features. It is now a universal grinder. The table shown at the left has a graduated angular adjustment through 45 degrees, and also a lateral adjustment for setting the top plate close to the disc. The vertical adjustment is five inches, and a protractor square is provided which may be secured to either the lower or right edge. The sliding table shown at the right is controlled by means of the hand lever, and all sliding surfaces are self-oiling and dust-proof. This latter feature holds when making adjustments, as well as when operating the tables, since a study has been made of the problem of excluding the dust from the wearing or bearing surfaces of the machine under all conditions. This table also has a protractor square. The work done upon this machine by the manufacturers is the same in quality as that found on regular machine tools, the bearing surfaces being scraped to a fit and great care being taken to have all important surfaces square with the faces of the wheels and the gradations of the protractors accurate.

* * *

It is rather unusual for a steamship to be moved on the water and yet not in the water, but this feat was performed recently in New York harbor in the case of the steamship Richmond, of the Old Dominion line. The vessel was in a balance floating dry dock in Erie Basin, and the dock was towed a distance of about a half-mile to a new anchorage. The Richmond is a screw steamer of the following dimensions: Length, 210 feet; beam, 33 feet; depth, 21 feet 6 inches; gross tonnage, 1,102 tons. The balance dock has a capacity of 3,500 tons.—Marine Engineering.



CHAPTER 3.—A LESSON IN PROJECTION.

In tinkering up an old steam pump Jones got into so many different kinds of trouble that he will long remember the day. By some "rule-o'-thumb" calculation he conceived that the crank marked A in Fig. 1 should be longer, so as to give more throw. This crank was not slotted, as is now sometimes the case, but was solid, with no way to lengthen it except to make a new one. Jones tossed the offending casting to his blacksmith with instructions to forge a new one two inches longer, "and be quick about it, too; no time to make a pattern and no foundry nearby if we had one." The blacksmith turned out a pretty

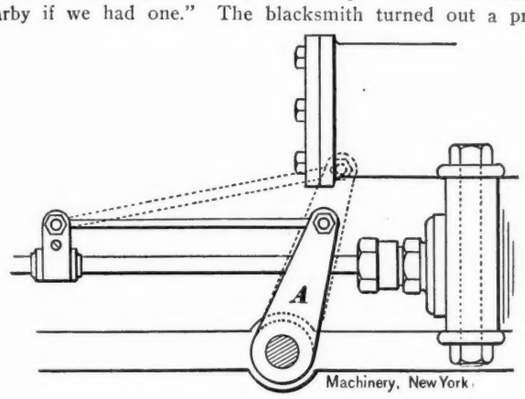


FIG. 1. JONES' FIRST MISTAKE.

creditable job, but when it was fitted up it was found to be so long that it struck the cylinder, thereby giving less throw than at first. The reader can see this by referring to the dotted lines in Fig. 1, and Jones might have seen it had he made more marks and fewer remarks. However, he thought he could get around the difficulty by bending the crank, so, picking up a piece of board, he laid the forging down and marked around it, changing his drawing as he progressed until it resembled Fig. 2.

"There," said he, with a satisfied air, "bend this same crank to that shape and you will have it."

"Well, but the throw of the crank is no more than it was in the first place," said the machinist who was fitting up the job. The boss seemed to be expecting this answer; at least he was ready with an explanation.

"Now, if you had watched me laying of it out you would see your mistake, 'cause the crank is the same length as before measured on the curve. Now, allus keep your eyes open and your mouth shet; a fellar can learn lots of things that way."

"But it's shorter between centers than it was before 'twas bent, Mr. Jones."

"That don't make no difference; the mollycules kinder follow around the curlycues, so that the longer the lever the more throw you get. Now just look at this old hand pump. Don't you s'pose them fellows know how to make pumps by this time? Ain't that handle curved jest like what we want, and didn't they do it so as to get more throw, jest as we are doing? I tell ye, them folks don't throw away iron nor waste no work without they see something gained by it. Now, you bend that crank jest as I tell you."

The curve was made according to Jones' drawing and the crank put in position, but now a new difficulty arose: the crank struck the stuffing-box before it reached the end of its stroke, as shown in Fig. 4, and Jones was again called upon for advice.

"Well, you didn't bend it according to my sketch, that's all. Hold the crank so, with the short hub toward you and the top will point to the right and that curve will just clear the stuffing-box."

"Sketch shows the long hub toward you," said the workman.

"No, it don't; hold it so, and look at it; see?"

"Yes, I see, and leave it to anybody if that long hub ain't on the nigh side according to your draft."

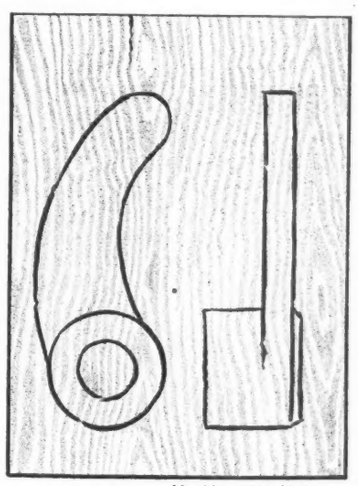


FIG 2. JONES' SKETCH.

Matters were becoming interesting; evidently the services of peace commissioners would soon be necessary. Now, in a country place all disputes are referred either to the minister or the schoolmaster, but it is doubtful if either would be qualified to act in the present case. However, Jones happened to think of his acquaintance with the bridge engineer, and it was at once agreed to accept his decision. He listened patiently to the evidence and smilingly declared it to be the old story of the red shield and the green shield, all depending upon how it was seen.

"Mechanical drawings," he said, "are commonly made either in the first angle or the third angle of projection."

"Didn't make mine on any angle at all; made it on a curve, full size," interrupted Jones.

"How did you go to work to do it," asked the engineer.

"Laid the forging down on a board and marked 'round it for one view; then I tipped it over on edge and squinted and marked at it as well as I could."

"Exactly, Mr. Jones, and your method was perfectly correct. It was as if you bent a piece of paper and held it up behind the forging while you marked around it (Fig. 5) and afterwards smoothed the paper out like this" (Fig. 6).

"Yes," cried the delighted Jones, "that's jest what I did and I should think any numbskull might understand it."

"Softly, Mr. Jones; your method was correct; but 'there are others;' suppose now that your paper was transparent and was held in front of the forging like this (Fig. 7), and you saw through the paper just as you see through that window, and you traced the outline on the paper as you saw it; then the right-hand view will appear reversed as compared with the one which you made" (Fig. 8).

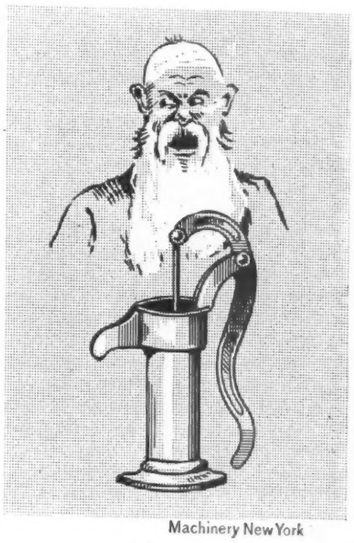


FIG. 3. "AIN'T THAT HANDLE CURVED?"

"Probably your blacksmith was used to this kind of a drawing while you had the other in mind. You were right in thinking that your way was right, but you were wrong in thinking that the other way was wrong. Both methods are right and both are in common use. Your way is known as the first angle, and the other was the third angle of projection."

"Thank ye, sir," said Jones; "much obleeged."

"Not at all, Mr. Jones; fact is, I was just thinking of coming over to your shop to see if I could borrow an expanding reamer."

"Expanding rimmer?"

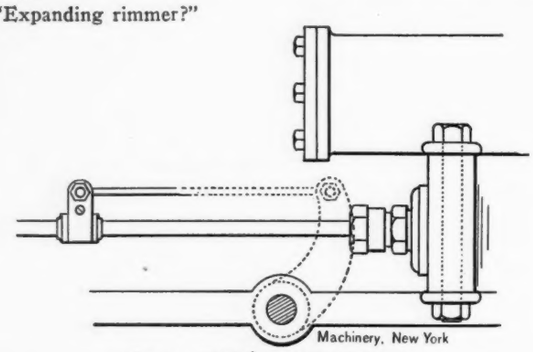


FIG. 4. JONES' SECOND MISTAKE.

"Yes, one of the kind that will fit different sizes of holes."

"Why yes, of course; guess my wife isn't using of it now." With which remark Jones disappeared into the house, leaving his astonished visitor wondering what kind of a wife or what

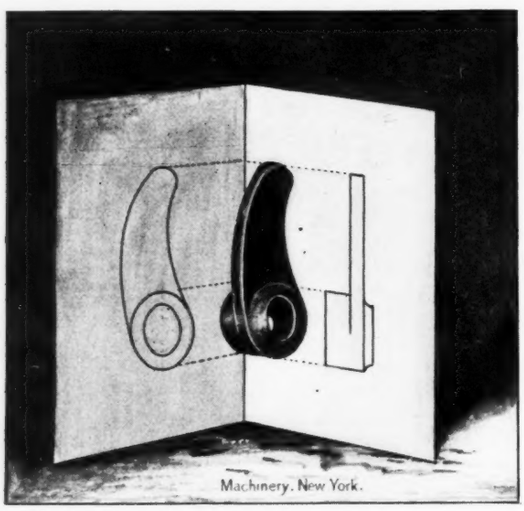


FIG. 5. THE FIRST ANGLE OF PROJECTION.

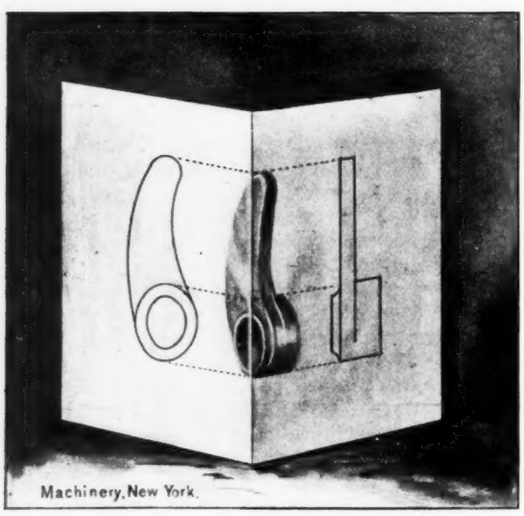


FIG. 7. THE THIRD ANGLE OF PROJECTION.

sort of a reamer he had. He quickly reappeared with a stove rimmer! One of the kind where one size fits inside of another, thus providing different sizes of holes! The engineer turned away sadly, went home, and ordered a year's subscription of MACHINERY to be sent to the Jones Engineering Co.

W. H. S.

A SCHOOL OF ELECTRICITY.

The Educational Department of the Harlem Branch Young Men's Christian Association, at No. 5 West 125th street, has added to its curriculum a course in electricity. The aim is to make this course of practical value to all men who are interested in any branch of electrical work.

The school, which opened on October 17, is in charge of Mr. William J. Clarke, who is a thoroughly practical man from every standpoint, having seen active service in nearly every branch of electrical work.

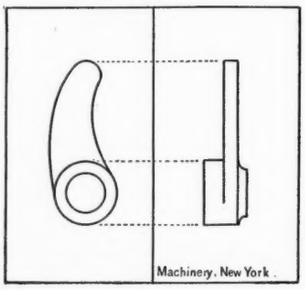


FIG. 6.

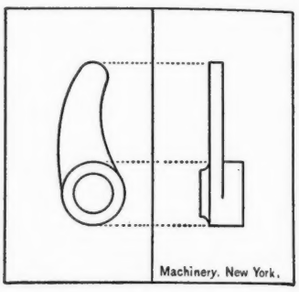


FIG. 8.

The sessions are held on Tuesday and Friday evenings, and the course will consist of forty-eight lectures. Mr. Clarke commenced by thoroughly grounding the class in the fundamental rules and principles of electrical engineering, and during the course he will cover fully the various branches of telegraphy, telephony, police and fire-alarm telegraph, arc lighting, alternating current apparatus, the distribution of electric power, the electric street railway, the electric automobile, the X-rays and wireless telegraphy.

Each lecture is illustrated by diagrams thrown upon the screen by means of a powerful stereopticon, so that each member of the class may readily follow the explanations of the teacher, and, in addition to this, a large amount of apparatus is used in illustrating the work. At the close of each lecture the members of the class will be permitted to ask questions, so that all may leave the class-room feeling that they have thoroughly mastered the particular subject under discussion during the evening.

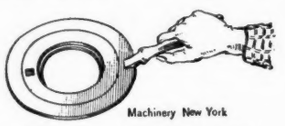


FIG. 9. AN "EXPANDING RIMMER."

The cost of the course is placed at the nominal fee of $10, including limited membership in the branch for one year, with its valuable privileges. Full particulars and application blanks may be secured by addressing the secretary.

* * *

WORTH NOTING.

The "National Druggist" gives some interesting information respecting the fire-extinguishing qualities of aqua ammonia which are worthy of attention, as the following will indicate:

"In one instance, where fire had originated, probably from spontaneous combustion, in a pile containing several tons of cotton-seed, and the interior of which was almost a solid body of live coal, a half gallon of ammonia completely smothered the fire. In another, which occured in France, the vapors of a tank containing 50 gallons of gasoline caught fire in the linen room of a laundry. The room was instantly a mass of flames, but a gallon and a half of ammonia water thrown into it completely and almost immediately extinguished the fire. The ammonia was in a glass demijohn in an apothecary's shop next door to the laundry, and was thrown into the room by the druggist as an experiment. To use his own words in reporting the circumstance * * * 'The effect was instantaneous, torrents of black smoke rolled upward in place of flames, and in a moment every trace of fire was gone. So completely was the fire extinguished, that workmen were enabled to enter the room almost immediately, where they found the iron tank of gasoline intact.'"

* * *

Joseph Clement, born in 1779, is said to be the inventor of the thread tap having a shank small enough to allow the tap to drop through the threaded hole. One of his workmen was the afterwards famous Joseph Whitworth, the originator of the present English system of screw threads.

GAS ENGINE DESIGN.—1.

EXPLANATION OF GENERAL PRINCIPLES.

E. W. ROBERTS

Before taking up the design of any piece of machinery, it is imperative that the designer should understand as clearly as possible just what that particular piece of machinery is to do. In the design of an engine of any kind, it is equally as important that what takes place inside the cylinder should be well known. The designer will find it of great assistance to first lay out the indicator diagram that he expects the engine will give; this is particularly so in cases where entirely new features are to be introduced. If he understands clearly what the diagram indicates, he will have at hand the principle data upon which to base his calculations.

Before taking up the subject of gas engine design, it will be necessary to briefly consider the series of operations which take place in the cylinder of a gas engine. With the exception of the Diesel motor, all gas engines now being manufactured employ the Beau de Rochas cycle. The series of operations which comprise this cycle was first proposed by M. Beau de Rochas in 1870. It was not, however, put into practical form until it appeared in the first Otto engine in 1876. For this reason it is quite frequently called the Otto cycle, although the honor of its conception belongs unquestionably to Beau de Rochas. There is also in use a modification of this cycle in which a portion of the necessary operations are carried on in a separate device or its equivalent in order to permit the entire cycle to be completed during one revolution of the crank-shaft instead of two revolutions as required in the Beau de Rochas cycle.

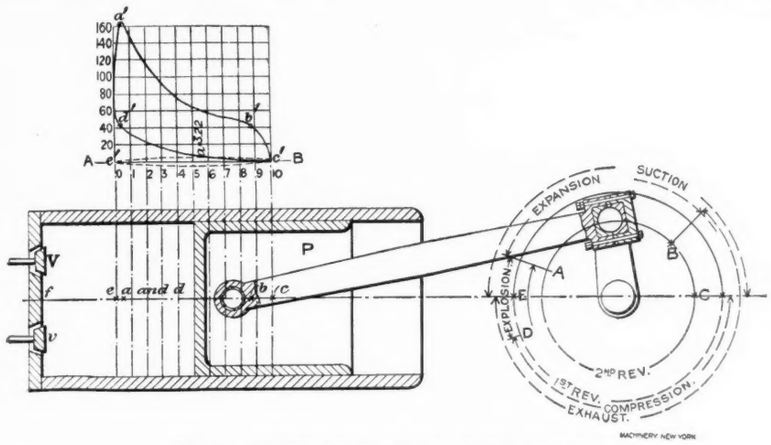


FIG. 1. SHOWING THE ACTION OF THE ENGINE.

The series of operations which take place during the four piston strokes necessary for the completion of the entire Beau de Rochas cycle is as follows: During the first forward stroke, gas and air are drawn into the cylinder and this mixture—called the charge—is compressed into a space at the end of the cylinder into which the piston does not enter. Just before the piston reaches the end of the compression stroke, or in some engines just as it reaches the end of the stroke, the charge is ignited. The ensuing explosion gives rise to a sudden elevation of pressure and temperature and during the next forward stroke the products of combustion expand. Just before the end of the expansion stroke, the exhaust valve is opened, permitting the contents of the cylinder to escape to the atmosphere. The following return stroke clears the cylinder of burnt gases, more or less thoroughly, according to the design of the engine.

The foregoing series of operations will be better understood by reference to Fig. 1, in which the indicator diagram given by the engine is placed immediately over the cylinder. For convenience of reference, the stroke of the engine is divided into ten equal parts, and lines are drawn from the cylinder to the diagram. Similar letters refer to the same point of the cycle and the letters are primed upon the diagram and capitalized upon the crank circle. The suction stroke starts at (e), the charge being drawn through the valve (v). Upon the return stroke, the admission valve (v) is closed and the charge is compressed into the space between the piston (P) when at the end of the return stroke and at the end of the cylinder; that is, into the compression space. The point of ignition is indicated upon the diagram at (d). As shown by the diagram, the pressure rises more rapidly at this point than during the early part of the compression stroke and at the end of the stroke the charge becomes fully inflamed, the pressure rising with great rapidity until the point of maximum pressure is reached, just before the piston starts on the expansion stroke (a), (b). The exhaust valve (V) opens just as the piston reaches (b), and from this point to the end of the stroke the pressure falls much faster than during true expansion. Upon the second return stroke, or while the piston is passing from (c) to (e), the products of combustion are driven from the cylinder.

The cycle is given in tabular form for easy reference:

1st Revolution:—Forward stroke; suction. Return stroke; compression, ignition, explosion.

2nd Revolution:—Forward stroke; expansion or power stroke (release). Return stroke; exhaust stroke.

The indicator diagram which is given in Fig. 1 is shown on a larger scale in Fig. 2. To have his engine produce such a diagram, should be the goal of every gas engine designer. There appears to be no reason why such a goal may not be reached by everyone, since the diagram is an enlargement of one actually taken from an engine operating on the Beau de Rochas cycle. In the writer's experience, the most successful engines on the market today are giving just such diagrams.

The notable points about the diagram shown in Fig. 2 are as follows:—The compression curve is smooth and is a regular curve from the beginning of the compression stroke to the point of ignition. The gas, ignited at (i), is fired just early enough to bring the point of maximum pressure at the beginning of the forward stroke, and the line (ab) indicating the rise of pressure lies at right angles to the atmospheric line (x), (y). The expansion line is smooth and does not show a series of steps as the pressure decreases. The release or point at which the exhaust valve opens is at (c), and it occurs at the proper moment to bring the point (d), where the expansion line meets the atmospheric line, directly at the end of the stroke. Wire-drawing on the suction and on the exhaust strokes, would be indicated by lines similar to (xsy). The writer is aware that there is some difference of opinion regarding what constitutes an ideal gas engine diagram. This is especially true with reference to the point of stroke where ignition should take place. The majority are in favor of such a diagram as is recommended.

The diagram shown in Fig. 3 is a puzzling one. The wavy appearance of the expansion line is produced, not by conditions within the engine itself, but by the vibration of the indicator spring. A somewhat similar diagram might be expected from a badly mixed charge in which case the rising side of the wave would be much steeper than the falling side.

Fig. 4 is reproduced from an actual diagram and shows the effect of late ignition, which takes place at (i) after the piston has started on the power stroke. The amount of work which is lost because of the delayed firing is indicated by the area enclosed within the dotted line at the left of the diagram proper. No better argument for early ignition could be given.

The effect which is produced by too early ignition is shown in Fig. 5. This is a diagram very seldom obtained because the defect is readily shown by the action of the engine and is easy to remedy. The point of ignition is at (i) and the loss of work is shown by dotted lines as in Fig. 4.

A study of the cooling effect of the water jacket may be made when the engine is running by taking cards when the igniter is shut off. Examples of such diagrams are given in Figs. 6 and 7. In Fig. 6 the compression and expansion lines are quite distinct from each other at the left end of the card showing that the cylinder walls are sufficiently warm to heat the air and raise the pressure of the cylinder contents, before the expansion stroke has begun. In Fig. 7 the compression and expansion lines are identical. In the writer's judgment, this proves that the cylinder walls are too cold for the best economy, an unnecessary amount of heat being carried off by means of the jacket water. In Fig.

7 will be seen the effect produced by constricted exhaust and air passages. The line (xey) indicates wire-drawing of the exhaust and the line (xsy) wire-drawing of the entering charge.

The effect upon the indicator diagram produced by late release, is shown in Fig. 8. The exhaust valve opens at (e) and the line of the diagram does not reach the atmospheric line (x y) until the piston has returned to (f), thus giving an unnecessary back pressure at the beginning of the exhaust stroke.

Figs. 3 to 6 inclusive teach an excellent lesson in what to avoid when designing a gas engine. The inlet and the exhaust ports, also the corresponding valves and passages, should be made of sufficient cross-section to avoid appreciable wire-drawing. Ignition should take place at such a point as to give maximum pressure at the beginning of the power stroke. In this connection it may be said that the best way to set an igniter is by means of the indicator. The exhaust valve should always open in time to produce a meeting of the expansion line with the atmospheric line just at the conclusion of the power stroke. The jacket water should be so controlled that an unnecessary amount of heat may not be carried away through the walls of the cylinder. It will be the writer's endeavor, as this series of articles progresses, to point out the best methods of accomplishing these results.

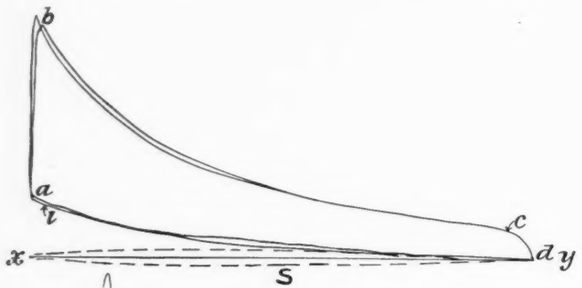


FIG. 2

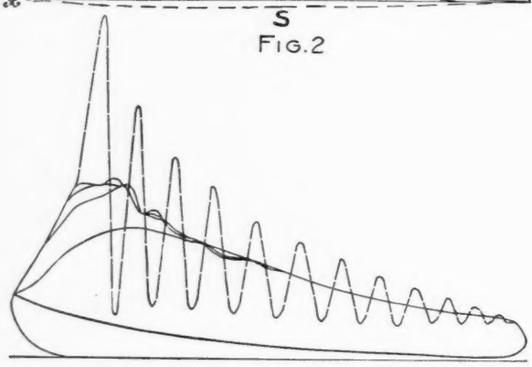


FIG. 3

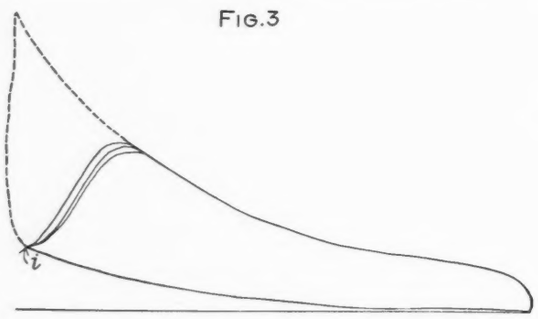


FIG. 4

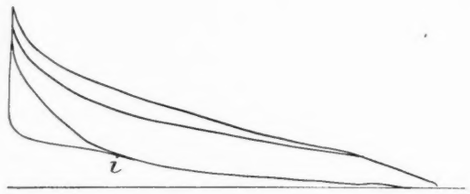


FIG. 5

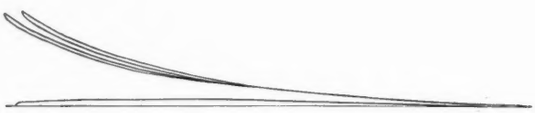


FIG. 6

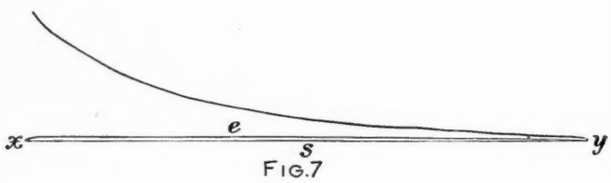


FIG. 7

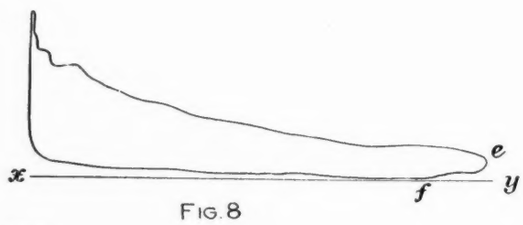


FIG. 8

When the mixture of gas and air is exploded at atmospheric pressure the resultant action of the gases depends upon two conditions, one of which is the quality of the combustible gas and the other, the proportionate amount of this gas to the air contained in the charge. A series of experiments made by Mr. Dugald Clerk, the well known English gas-engine expert, gave results which show the action of these mixtures. Mr. Clerk employed for his experiments the apparatus illustrated in Fig. 9. A chamber E, 7 inches in diameter by 8½ inches high, contains the mixture to be tested. A steam-engine indicator I, was attached to the explosion chamber E and the drum of the indicator was operated by clock-work as shown. The power to run the clock train was supplied by the weight W and the speed regulated by the fan (F). By means of this arrangement, the pressure exerted in the chamber (E) was transmitted to the piston of the indicator, which in its turn raised the pencil (q). In the conduct of the experiments a carefully measured and proportioned mixture of gas and air was drawn into the chamber (E) and the gases fired by means of an electric spark. The drum having already been set in motion, the pressure of the gas exerted on the indicator piston, compressed the springs raising the pencil (q). The pencil left a record upon the drum in the form of a curve somewhat similar to the upper portion of the ordinary gas engine diagram; vertical distances, measured on the line (xy) representing pressures and horizontal distances measured on the circumference of the drum representing intervals of time.

With this piece of apparatus the successive alterations of pressure, from the time the gas was ignited until it had reached a pressure closely approaching that of the atmosphere, were determined. Nine of the curves thus obtained are shown in Fig. 10 and they illustrate the action of one variety of gas when mixed with air in various proportions. The different curves may easily be distinguished by the aid of the letters a, b, c, etc., which are placed at each end of the diagram.

GAS ENGINE CARDS

Curve	a	b	c	d	e	f	g	h	i
Volumes of air to one of gas	14	13	12	11	9	7	6	5	4

In this figure, only that variation of pressure which takes place during the first second is shown. The line (x y) is divided into twenty equal parts, each one of which represents a lapse of .05 second The distance between each horizontal line represents a difference of pressure of five pounds. The time is measured from the moment when ignition takes place as indicated by the rise of pressure.

A careful study of the curves will show that when the mixture

is weak in gas, the rise of pressure is very low, the time between ignition and the moment when the gases reach their maximum pressure being nearly .45 seconds for curve (a) and but .04 seconds for curve (g). This lapse of time indicates very closely the fraction of a second it takes for the gas to become one entire mass of flame, or to express it differently, the time required for full inflammation. The rate at which the pressure rises after ignition is indicated by the inclination of the curve. This inclination is of course very steep when inflammation is most rapid, and the inclination decreases as the rate of inflammation is lowered, the curve becoming more nearly parallel to the lines (xy). The rate of fall of pressure is indicated by the inclination of the line beginning at the point of maximum pressure and continuing to the right of the figure. This rate of fall is not shown as far as the point where the pressure of the mixture reaches that of the atmosphere. It may be stated that this point was reached approximately 1.88 seconds after the time when the ignition took place.

It must not be thought that when the mixture is totally inflamed the gas has been entirely consumed. A peculiarity of such mixtures as this is that at the high temperatures produced in the gas engine a certain proportion of the gas remains uncombined with air and is not burned until a lower temperature has been reached. The effect of this phenomenon, called dissociation, is that heat is constantly being added to the mixture by this late combustion, keeping the pressures upon the expansion line much higher than could be obtained without it, under the conditions which are present in the cylinder. This phenomena is no detriment to the operation of the engine but is rather in the nature of an assistant. It must not be thought that the mixtures of gas and air which give the most violent explosions and consequently the highest initial pressures are the most economical to use. An illustration of this is given in the table shown below, the data being taken from the curves in Fig. 10:

1	2	3	4	5	6	7	8
Volumes of air to 1 volume gas.	Proportion of gas in mixture.	Maximum pressure in lbs. per sq. in.	Area of piston to each cubic inch of gas.	Total maximum pressure per cubic inch of gas.	Pressure per square inch .2 seconds after maxmum.	Total pressure to each cubic inch of gas .2 seconds after maximum.	Mean pressure on piston for first .2 sec. after maximum.
14	1/15	40	15	600	31	465	532
13	1/14	51.5	14	721	40	560	640
12	1/13	60	13	780	42	546	663
11	1/12	61	12	732	44	528	630
9	1/10	78	10	780	44	440	610
7	1/8	87	8	696	47	376	536
6	1/7	90	7	630	52	364	497
5	1/6	91	6	546	50	300	423
4	1/5	80	5	400	46	230	315

Although the above table shows what would take place in an engine having no compression, and which draws the charge in for about half the stroke and then ignites it, it is of assistance

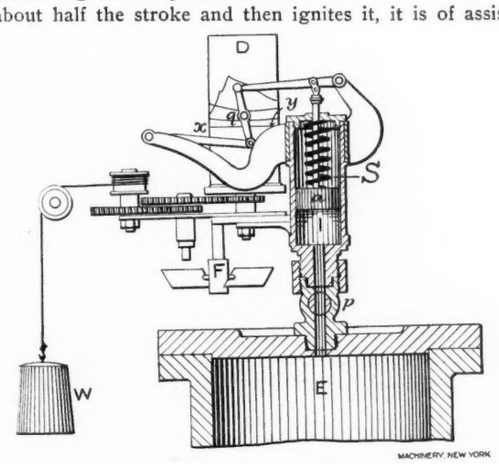


FIG. 9. EXPERIMENTAL APPARATUS.

to the designer in judging of the action of gases and in choosing the best mixture for a given engine. That proportion of gas to air, which gives the highest pressures for the quantity of gas used, is undoubtedly the best. For instance, let the distance between the end of the cylinder and the piston be exactly one inch; then there will be one square inch on the surface of the piston for every cubic inch contained in the above space. In order to calculate the highest pressure which will be given with a certain quantity of gas proceed as follows: If the mixture contain one volume of gas to seven of air, there will be eight cubic inches of the mixture for each cubic inch of gas, and in a layer one inch deep the surface of the layer will be eight square inches. Since in the preceding table the maximum pressure for a mixture of the above proportion is 87 lb. per sq. in., the total pressure exerted by each cu. in. of gas is 87 x 8 = 696 lb.

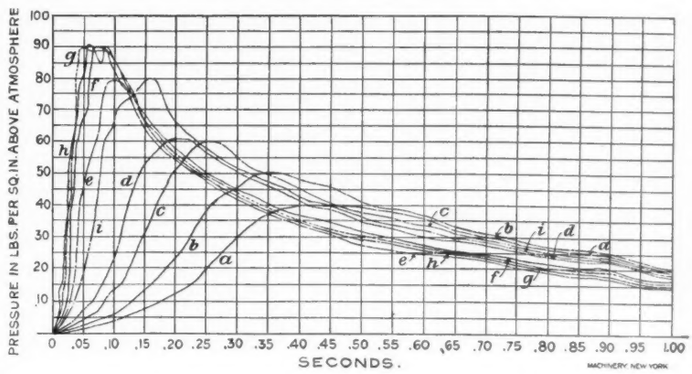


FIG. 10. SHOWING EFFECTS OF EXPLOSIONS.

That mixture which gives the best mean pressure for the first .2 sec. is that which gives 663 lb. mean pressure to each cu. in. of gas. This mixture is that containing 1 volume of gas to 12 of air. Could the power stroke be considered as taking place without increase of volume, the pressure given in column 7 would be that remaining at the end of .2 sec. and that given in column 8 would be the mean pressure for the same length of time. Thus the figures in column 8 give a means of comparison of the powers to be obtained with the corresponding mixtures indicated in column 1. For instance, that mixture having one volume of gas to 13 volumes of air has more than double the power of the mixture containing one volume of gas to four volumes of air, the ratio being 640 to 315, the power considered being that available during the first .2 sec. after maximum pressure. Do not imagine that an engine could operate without increasing the volume of the cylinder; this assumption is taken as a convenient means of comparing the values of the various mixtures. It is important that in each of the above cases the gas be considered as if it gave its maximum pressure at the beginning of the stroke.

* * *

SPECIFICATIONS FOR PUMPS.

Philip R. Bjorling, a Swedish engineer, who has become an authority on pumping machinery among English engineers, gives, in a recent number of "Feilden's Magazine," the following specifications, which he considers to be essential to a perfect pump:

"All valves and ports should be arranged so as to obviate the possibility of air lodging at any part, the air always rising to the highest point.

"The various sections of the pump should always have, as near as possible, the same area, for the reason that when the area increases or decreases the speed of the water is likewise affected; consequently, a shock occurs when currents of different speeds meet. This cannot conveniently be carried out with horizontal pumps, but the ports and passages should be kept of the same area as that of the suction or inlet pipe.

"All bends should have an easy curve, and all sharp corners should be avoided; all passages should be made round, when possible, because they create less friction and are stronger.

"The under-side of the delivery valve-seat should be level with, or above, the top of the pump barrel.

"The valve should never be allowed to meet a flat surface.

"The ram or plunger should not be flat at the end, as is the usual way adopted in England and America, but made in the shape of a parabola or an ellipse.

"Open-ended rams should always be avoided, because they increase the clearance space as much as the capacity of the interior of the plunger."

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NOVEMBER, 1899.

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The circulation of the three leading papers in the machinery trade, so far as it is possible to obtain the figures, is as follows:

The IRON AGE, about..... 7,000
The AMERICAN MACHINIST, about..... 12,000
MACHINERY..... 17,750

THE INFLUENCE OF A FOREMAN.

A machine shop is a commercial enterprise which is supposed to be carried on primarily for the interests of the owners. To conduct the various operations incident to the manufacture of machinery and tools, it is necessary to have other machinery and tools for their production. It is also necessary to employ men to operate these machines and tools, and foremen are required to supervise the efforts of the men and to direct their efforts in the interests of the greatest production for the least expense.

The characteristics of the foreman are often overlooked by machine shop proprietors. When he is hired the only inquiry is likely to be as to his executive qualities and his ability to produce economically. While a machine shop is not supposed to be a goody-goody sort of a place, the character of the men employed has a wonderful effect on the quality of the product and the general reputation of the shop. A machinist who is honest cannot scamp work intentionally nor hide work that has been accidentally spoiled, as his conscientious scruples will not allow him to do so; but if his instincts be dishonest or if the foreman's influence be bad from an ethical point of view, the general moral tone of the shop will be lowered and the honesty of purpose and effort that are always required to produce the best products will be wanting. We believe that no machine shop proprietor can afford on general principles to employ foremen who are known to be dishonest, immoral or of drunken habits, as the influence on the men in their charge will invariably be to lower the general status of the shop.

The power of influence is too great to be disregarded, and, as can be attested to by any one familiar with machine shop practice, the general characteristics of the foreman are more or less reflected on the men who look to him for orders. We believe that a foreman for a shop should have for recommendations, aside from his ability as a machinist, honesty of purpose, a clean mouth and a temperate mode of life.

* * *

THE COST OF THE COAL PILE.

About two years ago a committee was appointed by the Engineers' Society of Western Pennsylvania to investigate the cost of power, not as determined by expert test simply, but as shown by every-day commercial results, under various conditions and in different plants. The work of the committee was not entirely successful, because, as their inquiries demonstrated, comparatively few power users know, even with an approximate degree of certainty, how much their power is costing them. That there is this lack of definite knowledge is certainly not creditable to those who are supposed to have the economical production of the products of these establishments in their care.

The committee show very clearly how the fuel burned under a boiler during the lifetime of that boiler will make the first cost of the plant look very diminutive, by the following argument, based on the cost of coal at Pittsburg, which is probably the cheapest coal market in the world.

"Assume that one H. P. boiler capacity is the ability to evaporate 30 pounds feed water per hour. Assume an average ratio of coal to water as being 1-9. Such a boiler will require $30/9 = 3\ 1\text{-}3$ pounds coal per H. P. per hour, and in one day of 24 hours $24 \times 3\ 1\text{-}3 = 80$ pounds of best quality coal will be consumed per H. P. In 300 days the amount of coal thus burned reaches the very considerable total of 24,000 pounds, or 12 net tons. The best quality of coal will be required to give such a performance, and the coal will cost the average consumer nearly, if not quite, $1 per ton in Pittsburg. The annual cost of fuel then will be $12 per H. P., and this is much more than the first cost of some types of boilers, and is almost equal to the price asked for the very best. The lifetime of a good boiler ought not to be less than 15 or 20 years, and during such a life our aforesaid boiler may have consumed for each H. P. in capacity, fuel worth from $180 to $240, and even more. Such figures do not overstate the case—indeed they are entirely too low as compared with the actual results of ordinarily good plants, and it is not impossible that the results thus indicated may be 50 per cent. too good for a great deal of practice. If this be so, then a 20-year boiler may have to answer for the disappearance of, say, $360 per each H. P. of its capacity, or for a 100 H. P. boiler, the enormous sum of $36,000 "gone up in smoke." Of course such a boiler is "laid up" for part of its time, and may not be fired to capacity for 300 days per year, but in such case it is earning less, and the validity of the argument is not affected. Is such a sum worthy of scrutiny, and is the subject fairly comprehended by those whose duty it is to take care of such matters?"

There are difficulties in the way of determining the economy of a plant, particularly where there are numerous pumps, small engines, hammers, etc., but in view of the expense of operating compared with the first cost, it is a problem worth attacking, even if nothing more than a water meter and a pair of scales are used to keep records of coal and water used. In many cases it is not possible to arrive at the exact power consumed, owing to the fluctuation of the load, but the frequent use of the steam engine indicator will give some clue to the question. The committee suggest that in any plant there is scarcely a single feature that excels in importance the matter of correct size of an engine to do a given duty economically, and the idea of having an engine "plenty big enough," while well enough in its way, is easily capable of being overdone. Of course, the converse is also true and too small is no better than too big, except that errors in this direction are usually detected and corrected more promptly.

* * *

The recent shipment of American locomotives to Great Britain has elicited the consoling information (for Britains) that as far back as 1840 five locomotives were shipped from New York to England for use on the Gloucester and Birmingham Railway, and that, while the American of that day foresaw that the iron industries of Great Britain were to be injured by competition with the United States, the prediction was not realized, and is no more likely to be at the present time.

MACHINE TOOLS, THEIR CONSTRUCTION AND MANIPULATION.—4.

DRIVING LATHE WORK.

W. H. Van Dervoort.

The dog or driver connects the work with the spindle of the lathe, and in its common form is shown in Fig. 23. For all ordinary work this device serves its purpose well; for very accurate work, however, the effect of its leverage must be taken into consideration. As shown at A in the figure, the distance between the dotted lines represents the lever-arm, which acts on the center as a fulcrum, and produces or tends to produce a deflection in the work. Again, the force being applied at D, and the pressure of the cut at C, the tendency to bend the work will be greater than when the point D has moved round 180 degrees, or on the same side as the tool. The first of these objections is overcome by using the straight-tail dog, as shown in Fig. 24, with a stud or driver bolted on the face plate, and the second, by using a double-ended dog and driving from opposite sides, as shown in Fig. 25. The use of the double-ended dog is usually not altogether satisfactory, as it is very difficult to so adjust the drivers that the pressure against each will be uniform. Double-ended dogs are frequently made adjustable. The usual way, however, is to adjust the driver pins rather than the dog.

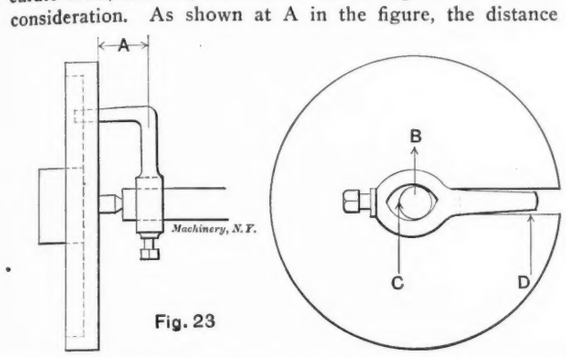


Fig. 23

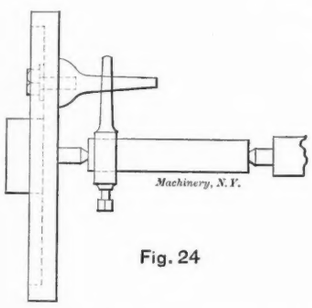


Fig. 24

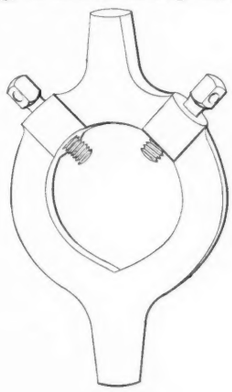


Fig. 25

As the dogs above shown depend on a screw to hold them securely on the work, care must be exercised or the work is very apt to be injured. The screw should always have a hardened, flat or oval point. While such a point does not hold as firmly as the cupped point, it does not cut into the work as badly. When used on finished work a ferrule of sheet brass, or, preferably, copper should be put on the work under the dog to prevent any injury to the work surface. The screw should be tightened enough to safely drive without slipping. If the dog slips it is quite certain to injure the surface.

For many cases, and more especially on finished work, the die and clamp dogs, shown at A and B respectively, Fig. 26, are excellent. These dogs are very nicely made of forged steel and hardened.

In Fig. 27 is shown a form of clamp dog very well adapted to the holding of tapered work.

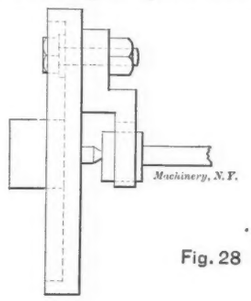
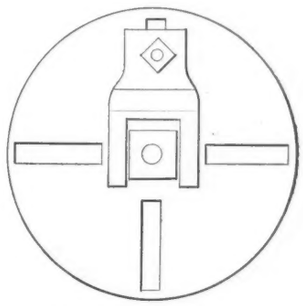


Fig. 28



In Fig. 28 is shown a bolt dog. This tool is clamped to the face-plate so as to receive the head of the bolt. It will drive square or hexagon head bolts, and, where a number are to be operated upon, will save the time that would be required to put on and take off the common dog.

When a dog must be used on the threaded end of a bolt or spindle it is necessary to protect the thread, or it will be injured by the dog screw. If the work to be driven does not require the screw to be tightened very hard, a heavy piece of brass over the thread will usually be found satisfactory. A common practice in cases of this kind is to jamb two nuts on the thread and place the dog on the outer nut. In Fig. 29 is shown a very satisfactory form of dog for use in such cases. It should be made of forged steel, tapped the required thread, and split as shown. The clamp screw locks it securely on the thread.

Very light work is frequently driven from the center without the use of a dog, thus enabling the work to be machined all over without changing ends. When an exact center is not required in the finished work the square center may be used to drive it. Instead of making a round center bearing on the live center end of the work, a pyramidal or square center is formed with a punch. This bearing fits over a square live center, which drives the work. A square center is a difficult one to keep in proper shape.

Another method of driving light work from the center consists in milling a thumb-nail notch in the live center end of the work, as shown at A in Fig. 30, and using a live center with a driver, as shown in Fig. 31. In this case true round centers are used.

A great deal of work done between centers does not require a dog, as a face-plate stud or driver will engage some part of the work, as shown, for example, in the case of a pulley in Fig. 32. The driver in such cases should be placed as far from the center as possible, thus making it firmer and steadier. The face-plate driver should be a stiff, substantial one. A bolt strung full of nuts and washers will answer after a fashion, but the one shown at A of steel, or at B of cast iron, in Fig. 33, will be found much more satisfactory. Two or three lengths will usually meet all requirements. Lathes are usually provided with two face-

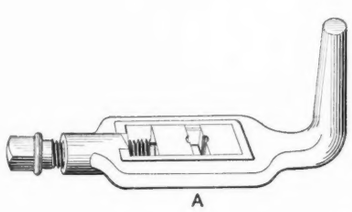
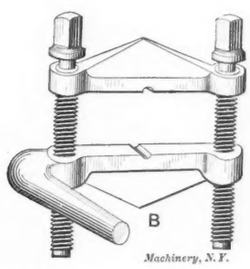


Fig. 26



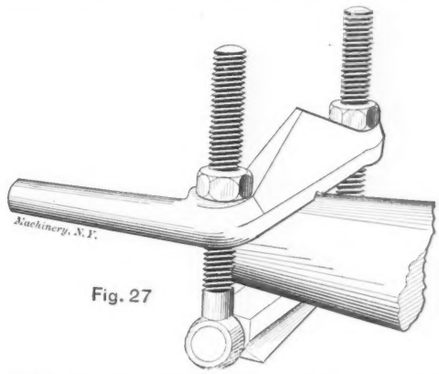


Fig. 27

plates, one of large diameter and one of small. The small plate is the one usually used for driving the dog on work held between centers. It is generally a round plate, with one or four notches. The plate shown in Fig. 34 is sometimes used, but for reasons of safety is not as good as the round one. At least one notch in each plate should extend well down to the center, thus enabling the use of the smaller dogs when operating on light work.

Lathe work not held between centers can be classified under the heads of center rest, carriage, face-plate and chuck work, the distinction between the two last classes being narrow. Center-

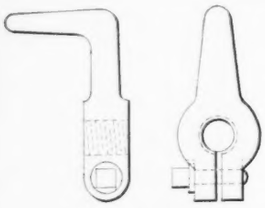


Fig.29

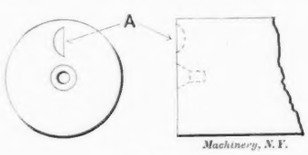


Fig.30

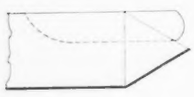


Fig.31

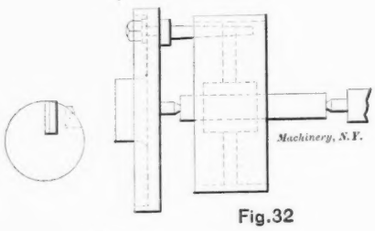


Fig.32

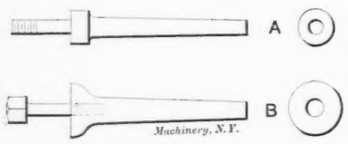


Fig.33

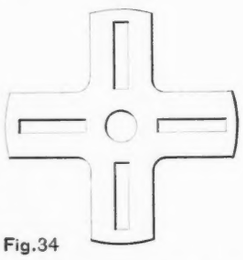


Fig.34

rest work includes all in which the center-rest carries one end of the work and the live spindle the other. Carriage work includes such classes as are operated upon by a rotating cutter while screwed to the carriage of the lathe. Chuck and face-plate work covers that wide range of operations upon work rigidly screwed on the live spindle.

The lathe chuck is a device for holding the work more firmly and adjusting it more accurately than is possible when clamped or bolted to the face-plate. Chucks are classified as independent, universal and combination. In Fig. 35 is shown an independent

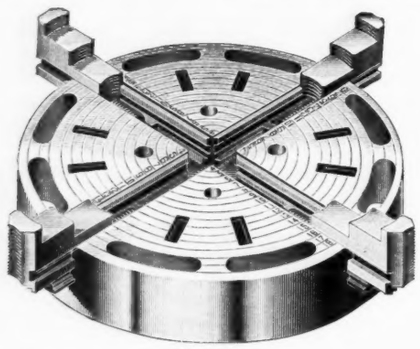


FIG. 35.

four-jawed lathe chuck. These chucks are made with two, three or four jaws fitted accurately in radial ways in a substantial plate or body. Each jaw is operated independently by a square thread screw. The jaws may, in order best to conform to the character of the work, be reversed.

The universal chuck, an example of which is shown in Fig. 36, is usually a three-jawed chuck, although they may be had with four jaws. In this chuck the jaws all move together. The universal chuck is used mostly on milling and grinding machine heads, screw machines, cutting-off machines and other places where it is desired to quickly center lathe work. When new, first-class universal chucks center work very accurately. After they become somewhat worn they should not be relied upon for exact centering.

The combination chuck involves both the independent and the universal characteristics, as by a slight adjustment it may be quickly changed from the one to the other. In many places this chuck is very nicely adapted, but for general, every-day lathe work the independent four-jawed chuck is more suitable.

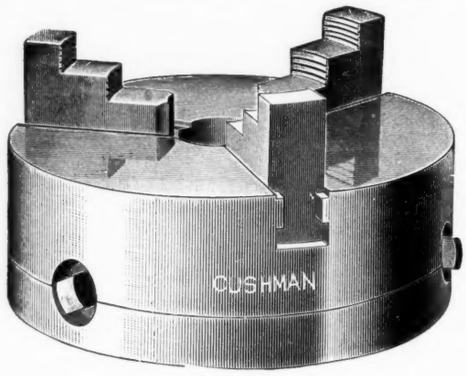


FIG. 36.

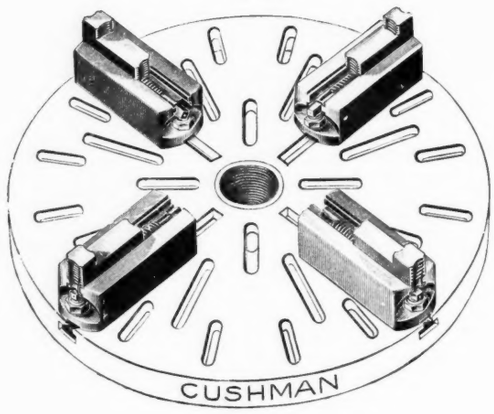


FIG 37.

In Fig. 37 are shown face-plate jaws. These jaws, which are perfectly self-contained, may be attached to a face-plate, and as such constitute a first-class independent chuck. They make a very satisfactory substitute for the larger sizes of chucks, and are frequently applied to very large face-plates.

It is frequently desirable to run a rough or curved hole on the dead center. This would quickly cut the center and ruin it for accurate work until reground. The hole in work of that

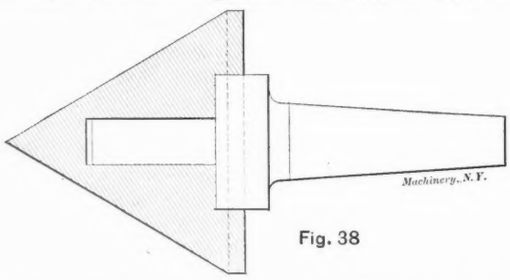


Fig. 38

character is usually too large to run on the regular center, if such were desirable, and either a large center must be provided to carry it or the hole plugged and a center bearing put in the plug. If the hole is concentric with the surface to be machined the large center is the cheapest and most convenient method. It is, of course, not adapted to the most accurate work, but for ordinary operations serves its purpose well. As it is necessary for the center to revolve with the work, to prevent its being cut, a special device is required. In Fig. 38 is shown such a center, commonly known as a pipe center. The construction is evident, the cone revolves on a stud and backs against a collar having ample bearing surface to take the thrust; it is also provided with suitable channels for its proper lubrication.

FAMILIAR SUBJECTS IN MECHANICS.—6.

TRANSMISSION OF POWER BY GEARING.

SAMUEL WEBBER.

I have endeavored, in a short series of letters, to discuss in a simple way the transmission of power by shafts, belts and pulleys, and give such useful hints as a long experience had led me to think might be useful to young mechanics; but I have said nothing about one mode of transmission, which, in a historical sense, should have preceded both belts and ropes in the conveyance of large quantities of energy, or power, and that is the use of gears.

The methods used for this transmission of energy may perhaps be classed in four groups, as follows: For short distances, without possible loss of velocity, gears; for moderate distances in parallel planes, belts; for longer distances, when the weight of a leather belt is an objection, or when the shafts are not parallel, ropes; and for extreme distances, when these well-known and simple mechanical methods are impracticable, electricity.

On the latter subject I do not propose to touch, leaving that to some of the younger men who are handling the subject practically to-day, but I will go back to the earlier method of gears and endeavor to show the philosophy of some of the changes which are generally taking place in their use and construction.

"To begin at the beginning," as the boys say, the action of a gear tooth is that of a simple lever, and the common picture of "Archimides moving the world," as shown on the seal of the A. S. M. E., is a complete illustration of the action of a gear tooth. In the first place, we have to consider the strength of the tooth, which depends on the material used, and as this is most commonly "cast iron," we will take that for a starting-point, basing our calculations on the known strength of this material, as derived from numerous observations, under the law given and accepted for the strength of a beam fixed at one end to which strain is applied at the other.

This is the square of the depth, multiplied by the width, and divided by the length, or, as commonly expressed, $\frac{d^2 w}{l}$. Now, the old experiments of Boulton and Watt on English iron gave the breaking strain of a one-inch cube of cast iron in this position as 7,200 pounds. Of this he allowed one-third, as reaching the "elastic limit," and then divided that by five (5), making what is known as a "factor of safety" of fifteen, or 1-15 the breaking strain, as the safe load which might be applied to the point of a tooth, or 480 pounds. "Trials of American Iron," by Mr. Thos. B. West, published in the "American Machinist," gave an average breaking strain of over 8,000 pounds, so that I think it safe to assume a breaking strain of 7,500 pounds, and, following Watt's rule, I get 500 pounds per cubic inch as the safe load for a cast iron gear tooth.

It must also be remembered that the strength of a gear-tooth does not require this assumed thickness of one inch to be carried out to the point of the tooth, but that it may be cut away on the under side in a parabolic form and still be equally strong, and if, as is usually the case with an involute tooth, the amount cut off from the point of the tooth by the curve is added by the reverse curve to the base, where the strain theoretically comes, it will be seen that a tooth of the initial thickness at the pitch line will be in excess of any required strength derived from the basis of 500 pounds per cubic inch.

For many years, in calculating the necessary thickness of gear-teeth, I followed a formula given me by the late James B. Francis, well known as a cautious and conservative engineer, and whose practice was always considered "to be on the safe side." Here is the formula: "Thickness of tooth to be equal to $\sqrt[2]{\text{pressure in pounds}} \times .020$; but in 1879, twenty years ago, my attention was attracted to a paper published in the Journal of the Franklin Institute by my old friend, the late John H. Cooper, in which he gave a collection of the various formulae for the strength and dimensions of gear-teeth from the days of Boulton & Watt, and Tredgold, down to Nystrom and Jones & Laughlin.

He calculated from these different formulae the horse-power which might be safely relied upon from a gear of 3 inches pitch, 1.38 in thickness of tooth, and 7½ inches faces, 5 feet in diameter, at 60 R. P. M. These results varied from 47.06 HP. by Carmichael (1814) and 66.17 HP., Boulton & Watt, to 147.27 HP. Jones & Laughlin, 163 HP. Haswell, and 295.59 HP. (for two teeth in contact), Nystrom, the latter agreeing closely with Jones & Laughlin.

I will not quote these various formulae, as they would occupy space unnecessarily, but they set me to looking into the matter and endeavoring to prepare a formula for my own use which might be relied upon, starting on the basis already known, of 7,500 pounds breaking weight, and 1-15th of that, or 500 pounds per cubic inch as a safe strain.

Now, I found many of these older rules were based on the supposition that the gears might be thrown out of proper mesh, so as to bring all the strain on one corner of one tooth; these I rejected entirely, as I considered that gears should be so supported and braced as to render such a strain impossible. Next I found many of them were calculated on the basis of a much longer tooth than is now generally used.

The earlier rules gave the length of tooth as ¾, or .75 of the pitch. The rule given me by Prof. Willis, of Cambridge, England, at that time the great authority on those questions, in 1851, gave the length as 70 per cent. of the pitch, of which 30 per cent. was above and 40 per cent. below the pitch line, leaving 10 per cent. for clearance when the gears were in mesh. He gave the thickness of the tooth at pitch line as 5-11th of the pitch, and the space between teeth on same line as 6-11ths. The Lowell Machine Shop tables, many years since, gave the last two dimensions as 29-64ths and 35-64ths, respectively, and these rules were generally approximately followed.

Now, these old rules were all based on cast gears, liable to shrink more or less irregularly in cooling, as in the case of large gears moulded from wooden patterns, which warped and shrunk more or less when not in use, and required a longer tooth and wider clearance spaces than are now needed for accurately cut gears with more perfect methods of construction.

It is now perfectly safe to reduce the total length of tooth to 6-10ths of the pitch, even for large gears, and for machine uses to 5-10ths, and also to reduce the clearance from 1-10th to 1-20th of the pitch. By so reducing the factor of leverage, we get a much stronger tooth, in which the thickness is nearly equal to the length, and is, in fact, fully so at the base, if an involute is used.

If we then adopt the standard formula for beams, supported at one end as stated previously, we have for the strength of the tooth $500 \frac{t^2 f}{l}$ (1) and as we have reduced l to very nearly the same dimension as t, or 5-10 P, as against 5-11 P, and so strengthened t at the base as to lift the weakest point up to not over 4-10ths from the tip, we may discard l, by calling it equal to t, and make the formula 500 f t (2).

Next, if, as usual, $F = 2.5\ p$, and $t = 5.11\ P$, and the multiplication made, it will result in $S = 5.50\ t^2$ (3).

Now, a horse-power is 550 foot pounds per second, and we therefore multiply the above by the velocity in feet per second, and divide by 550 to obtain the HP, which gives us $HP = \frac{500 \times 5.50\ t^2}{550}$ (4) or $5t^2\ v$ in seconds (5), or, as velocity is usually counted in feet per minute $= \frac{t^2 v}{12}$ (6), and this applied to Mr. Cooper's data, gives 149.57 H. P., as against 147.27 from Jones & Laughlin, or for which Nystrom's data for two teeth is just double.

I believe I wrote out this matter partially for MACHINERY some years ago, but as the paper has now many more readers it seems well to include it with the other notes on shafts, pulleys and belts as a summary of practical hints on "Modes of Power Transmission." I may also refer to various letters from Mr. W. H. Booth in the columns of MACHINERY and the "American Machinist," to show that this shortening of gear-teeth is attracting attention in Europe as well as the United States. There may be cases, such as those of very small pinions, of from 12 to 16 teeth, where the reduction of the length to half the pitch is impracticable, as it will not give a second tooth a chance to get hold before the first one lets go, but these are rare, and in machinery generally two if not three teeth are in bearing at once.

Many of the old formulae are still to be found in various "Engineer's Pocket Books," and if any one has a desire to see Mr. Cooper's collection of them he will find them in the "Journal of the Franklin Institute" for July, 1879. Mr. Wilfred Lewis published a paper on the strength of gear teeth within a year or two, in which he reduces the useful effect to be derived from a gear tooth very much as its velocity increases, but I fail to see the propriety of such reduction unless in exceptional case of "back lash" or sudden reversal of direction of the power.

The strength of iron is certainly the same at whatever velocity it may move, and if not giving a blow like a hammer the strength should not be affected, as in a train of gears in motion. The anvil is moving as fast as the hammer, and there is no blow, but a simple transfer of strain from one tooth to another without shock. In the case of very small pinions, where the second tooth does not fairly get hold, of rapid reversals, as in an iron rolling mill, or where a fly-wheel is still carrying on the anvil in the first direction, while the hammer has begun to move in another, such extra strength may be necessary, but for gearing in ordinary mechanical uses the factor of safety of 15 to 1 allowed above seems to be ample and sufficient. There is, however, one more very important point to which I should call attention in connection with this reduction of the length of tooth, and that is the necessity of firm and rigid bearings to keep the teeth always in mesh at the pitch line and in perfect alignment. With ordinary spur and pinion gears there is no difficulty in this, if the rule for shafting which I have previously given be followed, and the lengths of shaft on which the gears are placed are of such diameter as to resist pressure, but in the case of bevel-gears especial attention should be given to the bearings which support the gears, so as to prevent them from springing out of their proper right angles, and thus throwing the strain on one corner of the tooth.

* * *

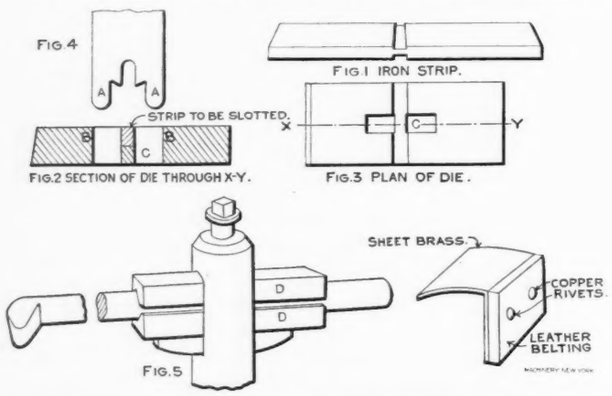
SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

DIE FOR CUTTING SLOTS—BORING TOOL—VISE CLAMPS FOR FINISHED WORK.

A Canadian correspondent—"W. J. T." of Toronto—sends us sketches and a description of a slotting die that was successfully used for cutting slots on both sides of iron strips so that they would be directly opposite in pairs. The iron strips were about six feet long, 3-8″ wide and 3-16″ thick. The slots were 1-4″ wide by 1-32″ deep, each pair being located directly opposite as shown in Fig. 1. The strips to be slotted are placed on edge in the die shown in Figs. 2 and 3 so that it rests on the cross piece or bolster (C). The chisel-edged punch shown at Fig. 4 is so constructed



that the edges do not begin to cut until the sides (A A) are entered and supported by the sides of the die (B B) thus preventing the punch from breaking and resulting in two perfectly square and parallel grooves. It is obvious that this method is a big saving of time over cutting the slots on a milling machine.

Boring tools that will work satisfactorily are perhaps the most difficult lathe tools to forge so the following scheme will be found worthy of adoption, especially for the smaller tools. Make two (V) blocks that will go into the slot of the tool-post as shown in Fig. 5 at (D D). Make the tool from round bar steel by hammering over a lip which is a very simple operation compared to forging a complete lathe tool. This tool slipped in the (V) blocks as shown in Fig. 5 makes a very convenient boring tool and one that has a number of advantages over the ordinary form, one of which is that its length can be adjusted to the depth of the hole thus making one tool do for deep or shallow holes.

If leather clamps be once used on vise jaws when holding work that has been nicely finished, their use will be continued, as they are far superior to copper or brass for the purpose. As sometimes used, they consist merely of two pieces of leather belting folded over so as to remain in position when the vise jaws are opened, but in this form they are something of a nuisance on account of being easily displaced and falling to the floor. The idea shown in the sketch shows how the trouble may be avoided. Two pieces of belting are cut to the size of the jaw faces and are riveted with copper rivets to two old brass jaws, thus giving the metal jaws a leather face which will not mar finished work even when tightly clamped by the vise.

A CONVENIENCE FOR CHANGE GEARS.

Mr. Adolph Munch, St. Paul, Minn., sends a sketch of a device which he has found useful for holding the change gears in place on small lathes. Instead of using the nuts provided for the purpose he shapes pieces of spring wire as shown in Fig. 1. These can be easily slipped into the recess of the stud, close to the shoulder where the thread terminates. While nuts often give

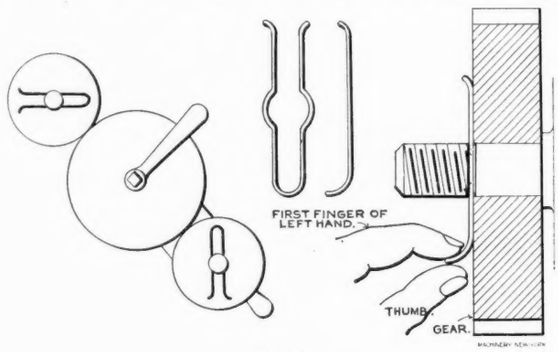


FIG. 6.

trouble by coming off, in consequence of the jarring of the lathe, making it necessary to hunt them up on the floor, these wire fasteners never give any trouble as they always stay in place. Mr. Munch has two fasteners in position as shown at the left in the sketch so that he is able to change the gears easily and quickly without hunting for a wrench or having the trouble of removing and putting on the nuts.

SECTION LINER.

I. R. Ish, Sault Ste Marie, Mich., sends a sketch (Fig. 7) of a section liner which, while in use in many drawing rooms, will be new to some of the younger readers who are now taking up drawing for the first time. He states that he saw the device used at the Michigan Agricultural College and that the outfit consists of a little piece of cigar box wood, (A), which is notched to re-

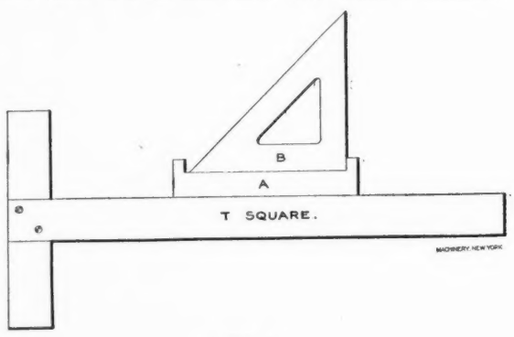


FIG. 7.

ceive the triangle (B), the notch being a little longer than one side of the triangle. By first slipping the bit of wood and then sliding the triangle along, holding the wood stationary, the triangle can be moved successively the required distance for the space between the lines. Mr. Ish incidentally mentions that the

Michigan Agricultural College is not, as its name signifies, entirely for those engaged in agricultural pursuits. They have a first-class mechanical course, with large and commodious machine, blacksmith and pattern shop and foundry. Many of these State Institutes throughout the country are doing excellent work by providing thoroughly good courses at a low cost.

BLACKSMITH'S CALIPERS.

"J. E. S." of Harrisburg, Pa., says there is a little kink in the making of blacksmith's calipers that is sometimes neglected and that is, constructing the rivet so that it will be stationary with the middle leg. The accompanying sketch shows the usual form of these calipers only a little more artistic than they usually appear but the idea is to incorporate in one tool, a means of determining two sizes as is often required when drawing a bar to certain specified dimensions. If the rivet (E) be made circular throughout its length, the movement of either the outer legs (B or C) will influence the other so that it will be almost impossible to get an accurate setting of both legs at the same time. To overcome this difficulty, the rivet should be made with a square part in the middle and the hole (D) in the middle leg (A) filed out to fit. The rivet is shown at (E) with the square part (F). The washers on the rivet are usually regarded as a luxury which can be dispensed with but the square hole—never.

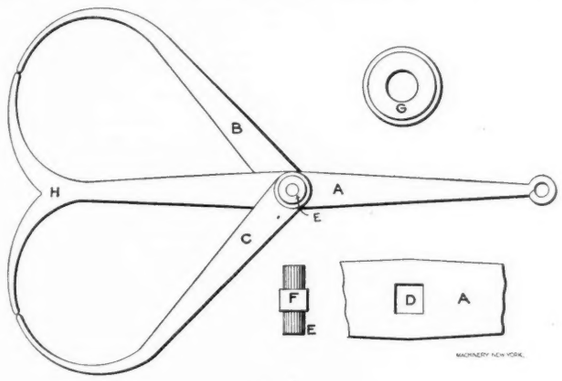


FIG. 8.

BABBITTING BOXES—SELF-OILING PULLEY.

Mr. J. R. Rand, Brattleboro, Vt., frequently has occasion to re-babbitt armature and motor axle boxes for electric cars, and has devised the arbor shown in Fig. 9 for the purpose. The body or cylindrical part is formed of three pieces (A, B and C). (A) and (B) are castings with the raised portions (d d) which make the oil runs in the babbitted box. The wedge (C) is driven out after the babbitt has been poured, thus relieving pieces (A) and (B) and enabling them to be withdrawn. The plates (W. W) serve to keep the parts of the arbor as well as the shell of the boxes in place while the babbitt is poured.

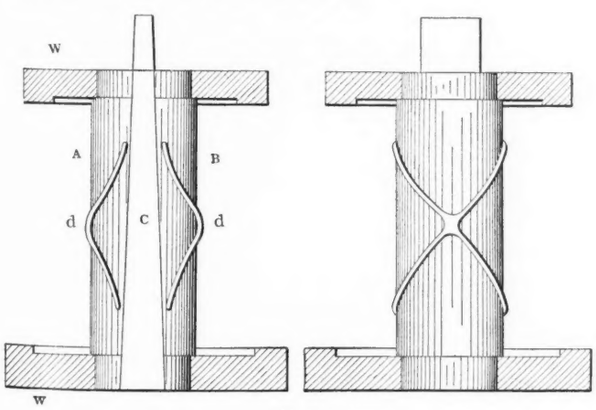


FIG. 9.

Another kink used by Mr. Rand is one that, while not new, is simple and may be of assistance. It is a method shown in Fig. 10 for inserting felt in the hub of a loose pulley. A hole is drilled near the bore of the pulley and then a slit is sawn between the bore and the hole that is to contain the felt. This felt will hold oil a long time and gives satisfactory results.

SCREW-NAIL-BOLTS.

Mr. Robert Grimshaw sends the following idea:

Where much erecting has to be done there is need of scaffolding and the more cheaply and quickly this can be put up and taken down the better. It usually happens that the successive stagings come in regular multiples of height, say seven or eight feet between, and if it can be arranged to use the same material over again, the better. For this work round spikes with a large head and quick thread, with a pitch of about two-thirds of their length will be found profitable as they can be driven with a heavy hammer and taken out with a brace or a socket wrench, without damaging the wood. Such a one is shown in Fig. 4. The time taken to bore holes for lag screws is saved. The spikes are necessarily round and should be slender. Square heads are the cheapest to make and loose washers are better than those forged out of the solid because cheaper and protecting the wood equally as well. For driving it may be well to have a steel head to fit over the squared head of this "screw-nail-bolt" against which to strike. This head should, of course, have a handle.

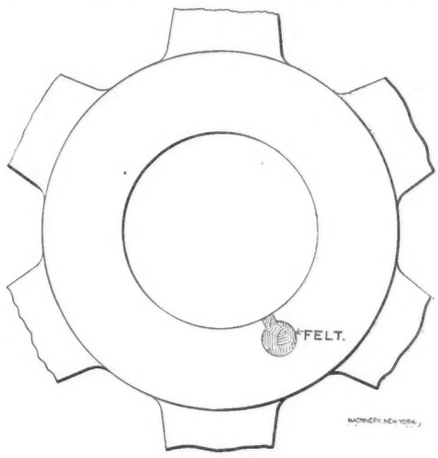


FIG. 10.

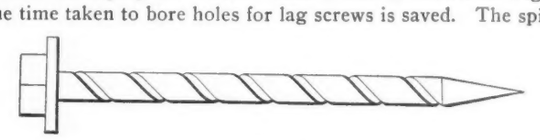


FIG. 11.

* * *

STEAM TURBINES ON LARGE VESSELS.

The successful results obtained with a Parsons' Turbine in propelling the yacht Turbinia at a high rate of speed has led many to ask why, if the steam turbine is so successful on a small scale and will produce a horse-power with a very small weight of engine, it would not be adapted to propelling merchant and naval vessels. Mr. Parsons himself believes there is no reason to prevent its application to fast vessels of larger size, including ocean liners and cruisers, and it is claimed that the advantages in these latter cases would be as great as in the former instances. It is also said experience has shown that the larger the scale on which the turbines are made the greater is the ease in fulfilling the conditions for the highest economy in steam, with a minimum of weight. In a series of articles in London "Engineering" Mr. Parsons has presented some interesting facts about the steam turbine, among which are the following dimensions and weights for the machinery for a vessel 600 feet long, as he has estimated them. First comes his estimate for a steam turbine equipment, and then follows the estimated data for an installation of reciprocating engines. It should be noted, however, that there is no reason why water-tube boilers should not have been taken for comparison in each case, instead of in the first case only, as Mr. Parsons has done.

Turbine Equipment.

Length between perpendiculars.....	600 ft.
Breadth, extreme.	63 ft. 3 in.
Depth, moulded.	42 ft.
Draught to bottom of keel.....	28 ft.
Displacement.	18,000 tons
Total bunker capacity.....	5,000 tons

	Tons.
Boiler-room weights with water in water-tube boilers	1,364
Engine-room weights with auxiliary gear and water in condensers	822
Shafting and propellers	210
Total	2,396

With 38,000 indicated horse-power, the weight of machinery is 141 lbs. per indicated horse-power. As compared with the above, the following are given as the weights for a similar vessel with reciprocating engines and Scotch boilers:

With Reciprocating Engines.

	Tons.
Boiler-room weights with water in boilers	2,225
Engine-room weights with auxiliaries and water in condensers	1,220
Shafting and propellers	305
Total	3,750

With 26,000 indicated horse-power, the weight of machinery is 323 lbs. per indicated horse-power. A vessel of the above size, and fitted with the steam turbine machinery and water-tube boilers, would, it is estimated, have an ocean speed of 26 knots. The advantages which, it is claimed, would result from the substitution of steam turbine machinery in a liner would be:

1. A reduction of total engine-room weight to about one-half that of ordinary engines.
2. A small reduction in steam consumption per indicated horse-power.
3. Complete freedom from all vibration from the main engines and a great reduction of vibration from the screw propellers.
4. A smaller engine-room staff to deal with the simpler and lighter engines and shafting.
5. Less consumption of oil and stores.

Regarding the above, Mr. Parsons states that the perfect balancing of the engines permits of very light engine-room foundations, and obviates that stress or strain on the hull which is produced by reciprocating forces of ordinary engines. The absence of lubricant from the internal parts of the engines is a benefit to the condensers and boilers. It diminishes the cost of cleaning and repairs, and enables very high boiler pressures to be used without risk. It is proposed that the steam should be reheated between the high- and low-pressure cylinders by coils of steel tubes containing steam at boiler pressure. Compound feed heaters, supplied with steam drawn from several points in the expansion in the main engines, would raise the temperature of the feed to above 212 degs. Fahr. The exhaust from the auxiliaries would also be added to one or more of the heaters. The trials of the Turbinia showed a total consumption of steam for all purposes of 14½ lbs. indicated horse-power of the main engines at 31 knots, but in a liner the consumption would undoubtedly be less, owing to the larger size and more perfect expansion, the higher boiler pressure, better vacuum and other minor details. Smaller size of the screw propellers diminishes vibration due to uneven action of the blades in the steam lines of a vessel. Smaller diameter also permits of some eight feet more immersion above the tips of the blades, so that the evils of screw racing in heavy weather will be mitigated and the vessel better able to keep her speed.

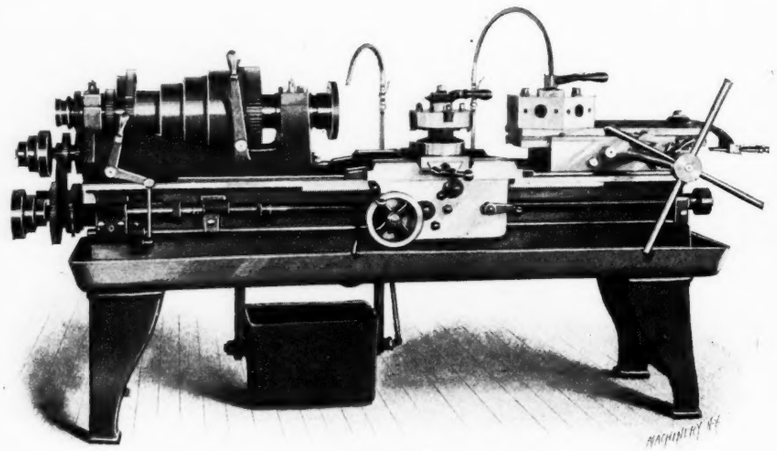
With the steam turbine the turning moment on the shafting is absolutely uniform, and these engines have much more momentum (or flywheel inertia) than ordinary engines. They will, therefore, not gather speed so quickly should the screws top the surface, and the engine governor will have more time to come into action and prevent racing. The shafting is only about one-half the usual diameter for equal total indicated horse-power, and can, therefore, be much more easily dealt with by the staff, and spare parts more easily carried. The four shafts are an additional safety against total break-down of the engines; and should one of the engines break down the other three are not interfered with, as they are quite independent excepting as regards the steam supply, which is controlled by valves. The small head-room required for the turbine engines and their quiet working permits of cabins being placed over part of the engine-room.

* * *

A UNIVERSAL TURRET LATHE.

The Prentiss Tool and Supply Co. have brought out a turret lathe intended for the manufacture of duplicate parts from bar stock or from castings. It contains some unusual features and appears to be an uncommonly well made and substantial tool with a large capacity, the manufacturers claiming that it is able to turn out as much as three ordinary lathes on the work for which it is designed.

The machine is 20" swing and has a bed 7' long, which gives ample capacity for any duplicate work that is likely to be done on it. The head spindle is 3½" in diameter and has a large hole clear through, being large enough to admit a 2" rough bar, thus making the tool well adapted for the use of bar stock. As will be noted the back gears can be thrown out or in by the movement of a lever, and two changes of the back gear can be obtained by the longitudinal movement of a pinion, thus giving twelve changes of speed with a four-step cone. The six-sided turret revolves automatically and has power to feed, which is obtained from a pulley on the end of the lead screw, thus enabling a large variation of feed to be obtained without complication. The turret has an automatic stop for each tool, and each stop may be adjusted without interfering with the others. An automatic stop is also provided, which is operated by the rotation of the lead screw. The direction of the feeds can be reversed by a lever shown in the front of the head-stock or by a handle at the left side of the tool carriage. An oil pump is provided and the turret is constructed so that oil may be forced through the hollow center, thus enabling the use of twist drills having oil channels and other tools requiring internal lubrication. A tool turret is provided in place of the usual tool-post, which has slots provided for four tools, that may be either the ordinary forger tools or any of the tool holders in common use. The arrangement for clamping the tools is somewhat novel, being a combination of a wedge and screw which locks the tool from the side. The tool turret is revolved by the hand lever shown at the top and a single movement of this lever to the right and back unlocks the turret, revolves it and locks it again in the new position. We are informed that the weight of the tool is about 3,400 pounds.



NEW TURRET LATHE.

* * *

In "Sparks from the Crescent Anvil," T. F. Dolby describes how he once "put on" stock by taking advantage of the principle that steel will expand in hardening. He had a steel ring ¾-inch thick, 4 inches outside diameter, with a smooth hole 1½ inches diameter. The ring was used as a die for punching medals, and had become worn and scratched inside, and if it were ground out smooth it would have been over-size. It had once been hardened at a low heat, and he heated it again to a higher temperature, removed it to a faucet, laid it on a board, turned the water into the hole and left it until cold. Result, the hole was smaller and could be ground out without making it larger than 1½ inches.

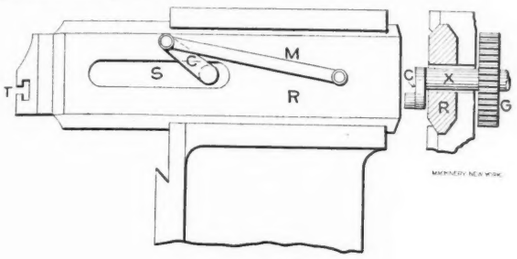
LETTERS UPON PRACTICAL SUBJECTS.

AN OLD SHAPER DESIGN.

Editor MACHINERY:

While in a railroad shop not 100 miles from Worcester I came across a shaper which was a little out of the ordinary and which was new to me in just this form.

As will be seen from the sketch, the ram is of deep vertical section, running in V guides. The power is transmitted through gear G, shaft X, crank C and rod M to the ram R. The slot S allows the ram to move past or around shaft X. The crank was, I think, slotted, and the ram end of rod was adjustable for varying strokes and positions of the ram.



AN OLD SHAPER.

It was built by the New York Steam Engine Co. and bore a patent date of July 23, 1861.

The base was round, but the saddle moved on a flat way in front as well as vertically on planed ways, so that it in no way interferes with our friend Forbes' milling machine.

FRANK C. HUDSON.

Tombstone, Arizona.

* * *

DRAWING OVERLAYS.

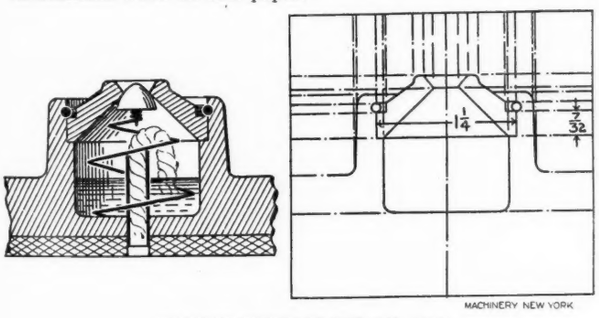
Editor MACHINERY:

In drawing complicated mechanisms the scheme described here, to save time and attain clearness, may interest readers of MACHINERY, as it has not been shown in any drawing treatises with which the writer is familiar.

The innovation lies in the use of tracing cloth between the original paper, and final finished tracing, as follows:

1. Paper.—This drawing with pencil outlines of machine, gives the assemblage of related parts or those which lie furthest from the eye.

2. Tracing Cloth.—Penciled train of mechanism or series of parts nearest to observer. As the first drawn lines show through tracing cloth, the relation of all is seen but the inevitable corrections and erasures on second plane are made without disturbing fundamental work on first paper.



TRACING TEMPLETS FOR OIL CUP.

3. Finished Tracing.—Made over both the foregoing. The first tracing being easily followed for inking gives those parts which are naturally in full lines, and when inked the first tracing may be removed without necessarily disturbing the register between No. 3 and No. 1 which may then be traced and the drawing completed.

Another application of this same prinpciple lies in making, on tracing cloth, a light outline of any frequently repeated machine detail, and running reference lines from the measurement points of detail to edges of this tracing template. Placing this on a drawing in progress will show directly if space at disposal will permit of the use of part, and when most favorable location is seen the part can be drawn in without making a single measurement other than simply extending the reference lines from the edges of the overlay.

For example: Take the self-sealing oil-cup illustrated herewith. After an experience with several hundred this has proved so good that it is used on any common bearing, and is of course drawn many times on different machines.

The tracing template for this is shown and its application will be readily seen from the preceding. Only the finished dimensions are given on template which may be repeated on the drawing.

New Britain, Conn. ROBERT S. BROWN.

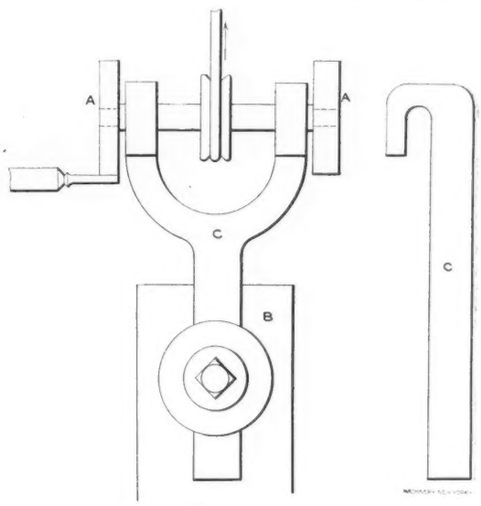
* * *

PIVOTING BALANCE STAFFS IN WATCHES.

Editor MACHINERY:

In pivoting balance staffs considerable skill and patience are required in doing the work by the usual process, which is to drill into the broken staff and drive in a piece of steel wire as tightly as possible and yet not split the staff. This piece of pivot wire is hardened and tempered to such a degree that it can just be turned with a keen-edged graver. The process is slow and oftentimes tedious.

A skillful watch-maker of my acquaintance has adopted a different way and is doing very satisfactory work. He grinds the pivot to the desired shape instead of turning it, taking less than



GRINDING RIG.

one-half the time required for the latter operation. In MACHINERY May, 1897, is shown a handy grinder which is used for this purpose, and the essential features of the sketch are reproduced herewith. (AA) are the carborundum wheels; (B) is the slide rest, and (C) the frame of the grinder referred to. (C) is shaped as shown at the right of the sketch and the axle of the grinder is held in place by the pull of the belt as indicated. The arbor can be easily slipped out so as to change the positions of the wheels if desired. The wheels should be driven with a small belt from a countershaft at the back of the bench and as the arbor does not run in solid bearings, but is free to go and come as much as the elasticity of the belt will allow, there is no danger of pressing the wheel so hard against the pivot as to break it off. It will be observed that the grinding wheels are at the back of the work and therefore the workman can see just how he is progressing.

Some workmen may say that a fine pivot cannot be made in this way, but nevertheless it is being done every day, and the public is being benefited by having to pay only about one-half the usual rates for pivoting. F. H. F.

* * *

THE VALUE OF A PRACTICAL EXAMPLE FOR ABSTRACT ANALYSIS.

Editor MACHINERY:

An editorial in the September MACHINERY under the "New School Year" reads in part "First and last there is a great deal of fault found with the technical schools because graduates do not always take hold of practical work with the degree of success that they ought to after four years of work. If these criticisms

are justified it is probably because the professors fail to impress their students with the importance of getting in touch with actual machine construction during their years of study."

True, a part of these criticisms are justified, and a part, also, unmerited. Too often the practical man, as opposed to the technical graduate, has a strange antipathy for the college man simply because he is a college man, and looks upon the latter's efforts with marked cynicism and apathy. The self-made engineer is truly to be commended for his perseverance and thrift, but his success, after years of uphill toil, does not justify him in condemning the young graduate because his four years of general technical training does not fit him for undertaking every conceivable branch of machine construction without further experience.

It is not however, the object of this paper to uphold the technical graduate, but to state some reasons why professors fail to impress their students with practical applications of abstract theorems. Take, for example, that particular branch of kinematics which pertains to the analysis and synthesis of variable motion mechanisms. In all treatises of kinematics, from the masterly analysis of Reuleaux on the Functions and Principles of Mechanism to the very latest works on this subject, the Whitworth quick return motion, the oscillating quick-return, etc., are exhaustively discussed in abstract, no attention, however, being paid to the practical application of these principles to shapers, planers, pumps, etc. True, some institutions have small models of these appliances, which, unfortunately, are only examined superficially, and in no instance, as can be learned, are these models and the abstract problem analyzed in conjunction.

Interviews with graduates from various technical colleges, and experiments conducted with the present class of undergraduates at Armour Institute of Technology, prove conclusively that the trouble lies wholly in the method in which the practical and theoretical are studied.

For example, a problem requiring the theoretical velocity analysis in abstract, of an oscillting quick-return motion and its practical application in detail to a shaper was given to a representative class of undergraduates in the following manner:

The class was divided into three sections, each section working independently of the other. The students of Section I. were asked to make a theoretical analysis of this problem, and after its completion, to examine a shaper equipped with the mechanism in question, and then make a detailed design of the machine as applied to their abstract theorem. Those of Section II. were asked to examine the shaper first, and after becoming thoroughly conversant with the modus operandi, were to analyze the mechanism in theory and complete a detailed design as in Section I. The students of Section III. were asked to analyze the theoretical problem and the shaper in conjunction and proceed as in the other sections. Section III. to a man completed the problem first, Section I. next, and Section II. last. Similar problems were given throughout the entire year and the different sections were interchanged, but the result was practically the same. Examinations on this work at the end of the quarter were decidedly in favor of Section III. Similar experiments were conducted with the class in governor design, and the results prove conclusively that a study of the abstract problem in conjunction with its practical application impresses itself more readily upon the students than the systems now in vogue, and, of still greater importance, makes a more lasting impression.

G. F. GEBHARDT,
In charge Dept. Machine Design,
Armour Institute of Technology, Chicago, Ill.

* * *

DRILL-ROD CHUCK—HOT AND COLD WATER.

Editor MACHINERY:

Machinists and tool makers find it convenient to use cold rolled steel shafting and drill rods for much of their work. I use drill rods for many purposes, but have found it difficult to devise a way to hold them so that they will run true in the chuck. I made a bell chuck with a set screw on one side, having the hole of such a diameter that the rod was a snug fit in it; but in a short time the chuck was out of true and satisfactory results could not be obtained with it. Another chuck with a taper nut also proved just as unsatisfactory. I could not induce the "old man" to buy a draw chuck, so I made one like sketch, Fig. 1.

(B) is the body of the chuck and was made to screw on to the spindle so that the threads would be a snug fit. A sleeve (A) was made of unannealed tool steel, and on one end of it a buttress thread was cut as shown in the sketch at (T). Six slits were sawn in the end of the sleeve on which the threads were cut, and the bushing was forced into the body so that it was solid with it.

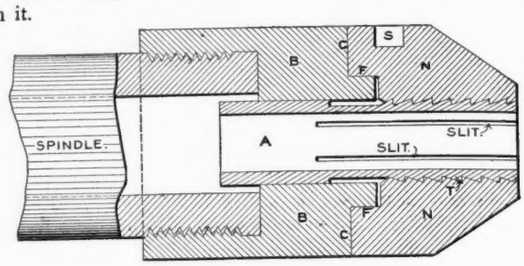


FIG. 1.

The nut (N) was bored and threaded with buttress threads to fit the threads on the sleeve. This nut fitted the body of the chuck nicely at (F) so it would always remain central, and when it was screwed up against the body at (C C) it had a tendency to slip on the thread, thereby gripping the work.

The bushing was made of the largest stock that the chuck body would hold and with the size hole desired. Bushings having different diameters of holes can be used to fit different rods. (S) is a hole for the spanner wrench.

Another little device has been very convenient for our use at the shop and is illustrated in Fig. 2. We wanted warm water to

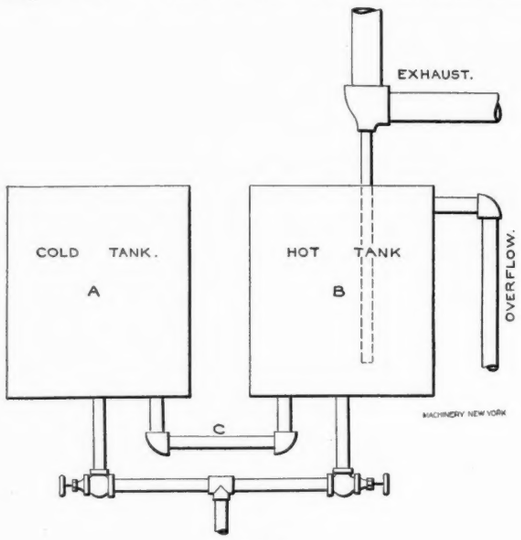


FIG. 2.

wash with, and I piped from an elbow in the exhaust pipe to a hot water tank as shown at (B) in the sketch. This pipe was ¼ inch in diameter and ran nearly to the bottom of the tank. This arrangement made the water too hot and so I put up another tank shown at (A) in the sketch, which was supplied with cold water. The hot tank (B) was then fed from the first one of the pipes at (C). The connections shown underneath, with their valves, thus enabled us to draw either hot or cold water, or parts of each, and water of any temperature between the two could be obtained. This arrangement gave us a satisfactory hot and cold water system for the shop.

Decatur, Ill. W. A. BRIGHT.

* * *

FOUND!

Editor MACHINERY:

The ingenuity of the New England Yankee is, so they say, proverbial, but I recall an incident that causes me to question his right to this reputation as compared to that of his kind in "Ole Virginy." It was an unusually cold morning and I was waiting for a train at a town of considerable importance in the above-mentioned state. The mercury in the thermometer was only a few degrees above the zero mark and I stepped into a small machine-shop near by to get warm. (Somehow "machine shop" always seems to spell "home" to me.) This particular shop

was a very humble, tumble-down home however, hardly large enough for two men to move around in, and I found the proprietor with an overcoat, mittens and a thick winter cap on, stuffing wood into the top of a "boot leg" stove. There were great cracks in the floor that would permit a lead pencil to pass through quite readily, but then the shop was set up on boulders so that one could crawl underneath and recover anything that fell in these cracks, of whose proximity I was reminded by the way the wind whistled through them. Well, I shivered and shook and my teeth chattered and I told the proprietor I should think his feet would freeze in such a place. Without saying a word he stuck his foot up on the top of the stove, pulled up his trouser leg and revealed to my astonished gaze an inch and a quarter shank with the black paint cracking off of it as it does

FOUND!

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off an old wagon wheel. Pausing between every word to whittle off a chip from a stick of wood he had in his hand, he remarked drily: "What do you think of that for a shin bone? I'll tell you what it is, there's nothing like being adapted to one's surroundings. I suppose you are also wondering how I can earn enough to keep even that hard wood shank as fat as it is. I couldn't if I were not able to do many things that most mechanics think they can't do if they have not served a seven years' apprenticeship to learn. I am prepared to make anything from a carpet tack to a cyclone. Here, put one of my business cards in your pocket; you will find a few of my specialties mentioned on that. Of course, a shop like this don't provide the most sumptuous living and besides having to attend to business, I have to raise my own chickens. But my neighbors, sad to say, are not so self-reliant nor so conscientious about leaving other people's property alone, and so, one morning last spring, I had but one pullet and a rooster left out of my whole flock, and to make matters worse that pullet broke her leg. But in spite of all this I didn't despair. The accident to my own leg had given me experience, so I cut off the chick's useless foot and bound up the leg. The wound healed rapidly; when it was quite well I stuck a clothes pin on to the end of the stump for Mrs. Biddy to hobble around on. You ought to see how sleek and fat she grew; and one fine morning I found her with a brood of chickens around her who appeared to be listening to her 'fo' the war' and 'ku-klux' stories. But the most curious part of it is, that each of them hatched out with one 'peg leg.'"

I took it for granted that my friend of the wooden shin could thoroughly adapt himself to circumstances and didn't wait to hear any more. When I got settled in the train I took his card out and looked at it. I will enclose it herewith so that you can add a reproduction of it to this letter; it may serve as a pointer for the young Yankees who think of going down South to start in business when they have finished their apprenticeship.

I don't see rock-maple shin bones mentioned as one of his specialties but I am confident that he made the one he walks on.

MILO.

* * *

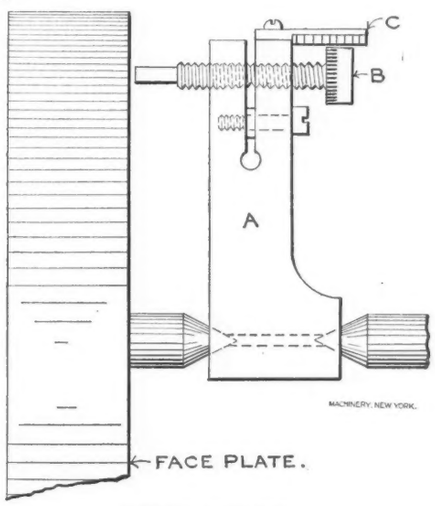
TESTING CENTERS—POINTS IN LATHE DESIGN.

Editor MACHINERY:

In his article upon testing and adjusting engine lathes, in the last number, Mr. Van Dervoort mentions the time-honored method of testing the alignment of the centers by turning a short distance at each end of a bar placed between the centers and then calipering the two turned portions. If they are of the same diameter the two centers are in line.

This method is an accurate one, because it is possible to measure the diameters of the bar very closely with a micrometer, but it has the objection that it consumes considerable time. Where one is operating a lathe without a taper attachment, and has to set over the tail center frequently, it is annoying to have to hunt up a bar and center it and take the time required to turn up the ends two or three times and test them for uniformity.

The accompanying sketch shows a device which would not only be as accurate, or perhaps more accurate than the method just described, but it would be more rapid, and it would pay to have such a tool in the shop. The bar A is drilled and countersunk on opposite sides of one end to fit the lathe centers, and on the other end there is a micrometer screw which is made long so as to be adapted to lathes of varying size. To use put the instrument between centers, as represented in the sketch, clamp the tail stock and turn the bar until it lies in a plane in which the two centers are supposed to lie when out of adjustment. Turn the measuring screw until its point touches the face-plate. Note the reading of the screw, move it back two or three turns and indicate by a chalk mark where the screw came in contact with the face-plate. Now turn the face-plate half around, together with the instrument, and take a second measurement. The difference between this and the first measurement will give an indication of the distance that the two centers are out of line.



TESTING INDICATOR.

I have a device similar to this, only not so elaborate, which I have used for a number of years and have found very convenient. There is no micrometer screw, and I depend on a sliding pin and set screw with a "feeler" in the shape of a few thicknesses of paper between the pin and face-plate. The idea is not original with me, but I do not know who should have the credit for it. The device was described to me by a special apprentice, who said he had seen it at college.

In my last letter I expressed an aversion to novelties in shaper design, when as good, or better, results can be obtained by adhering to well-established practice and making all the parts extra strong and heavy. In the case of engine lathes, however, there is one part that is bound to wear out, however generous its proportions, and that is the lead screw. There would be no serious objection to this if the wear were uniform on the whole length of the screw, but this is impossible, as every lead screw

is used more at a point a short distance from the head stock than elsewhere, and the pitch gradually changes from this point to the end nearest the tail stock, where the wear is practically nil. Why not, then, make the lead screws of engine lathes reversible, so they can be turned end for end? One end could then be used for "common" and the other kept for "best," or until the first end became so bad that it was unsuitable for any purpose. Here is an opportunity for "freak" designs, as you style them, where the problem does not seem to be susceptible of solution by more legitimate means.

While on engine lathes, I cannot refrain from mentioning that a point needing stiffening in many of this class of tools is the tail stock spindle. It would do no harm if it were made half again as large in diameter as is the custom. It may be argued that when heavy work is to be turned the tail stock itself should be moved up, instead of extending the spindle, but nevertheless it is more convenient to extend the spindle than to slide along the tail stock itself, and as long as this is the case the spindle will continue to be extended, and very far, too, sometimes, by most lathe hands. This is the end of the lathe that has to take the strain of most of the heavy cutting, and, in my opinion, the tail stock spindle should be more substantial.

OLIN SNOW.

* * *

TESTING ENGINE LATHES.

Editor MACHINERY:

I noticed in the October issue of MACHINERY an article of interest on the testing and adjustment of that universal tool—the engine lathe. Every machinist running a lathe ought to know how to find errors in the alignment of his machine and how to correct them, but it is a notorious fact that a large proportion of the best lathesmen are at a loss to test their machines in any other way than by turning or boring a sample piece. While this test may detect inaccuracies, it, however, is a very poor guide for the correction of the same, simply because the test does not show where the inaccuracy lies. It is evident that any method, no matter how refined it may be, is not of much value if it does not show exactly where we are to go to correct the fault. For this reason I feel compelled to criticise some portions of Mr. Van Dervoort's article, as the tests mentioned do not positively locate the error. Thus, he says that to test the carriage cross-slide for being at right angles to the axis of the spindle, take a light cut across the face-plate and test the accuracy of the facing with a standard straight-edge. If the face-plate be perfectly plane the alignment is correct; but is it? Suppose, after testing a lathe in this manner, it was found to bore a hole tapering? What is the trouble, and what are we going to do to correct the fault? Cut and try methods are tedious, and in this case the chances are that the inaccuracy would be aggravated in one place while they were being corrected in another.

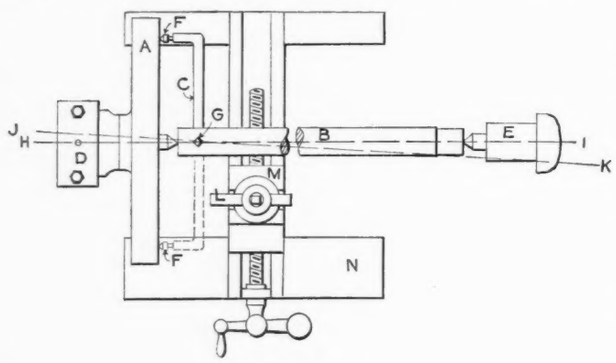


FIG. 1.

There is, however, a simple method for testing and locating the errors of an engine lathe which is used to a limited extent, but which does not appear to be generally understood. The materials for the test are those that can be found in any shop, and but little work is required to rig them up into a reliable testing apparatus. Suppose we are to test an 18" lathe that is six feet between the centers. A round bar of iron 2" in diameter and about five feet long will be required as the principal part of the testing appliance. This bar must be centered nicely, the holes being drilled and reamed with a center reamer of the same angle as the centers of the lathe. A hole must be drilled through the bar near one end, and another should be drilled and tapped at right angles to the first for a set-screw G to hold the angle-piece C shown in the accompanying figures—1, 2 and 3. The part C should be made from 5/8" iron rod, so it will be quite stiff, and should have a hole drilled and tapped in the outer end for the screw F. The head of this screw ought to be rounded to approximately spherical shape, or bluntly pointed, so that if the screw be adjusted out or in, the point of contact will remain about the same distance from the center of the face-plate A. One end of the bar B should be turned and finished smoothly for a short distance from the end opposite that carrying the part C.

The first test to be made may properly be to determine whether the center bearing is bored so that it is not slightly eccentric with the center of the spindle. The determination of this error is, however, a minor matter, as there is not one lathe in a hundred but the center will run out slightly when placed in a position diametrically opposite to that in which the point was turned. The result is that machinists generally mark the center for the spindle when it is trued up so that it can always be put in that position when used. To test it for eccentricity, however, all we need to do is to turn the point off nicely and then remove the center and replace it in the hole so that it will be turned one-half way round. Then place the bar B on the centers, with the turned part next to the face-plate. The cross-slide is run up till the end of L touches the turned part of the bar B with a piece of tissue paper held between the two. Now hold the bar stationary on the centers and revolve the face-plate slowly, and note whether the pressure increases and decreases on the tissue paper during the revolution. If it does not, with the center in different positions, the center bearing may be regarded as being accurately located, but it will almost surely show a variation, as the test is quite a rigid one.

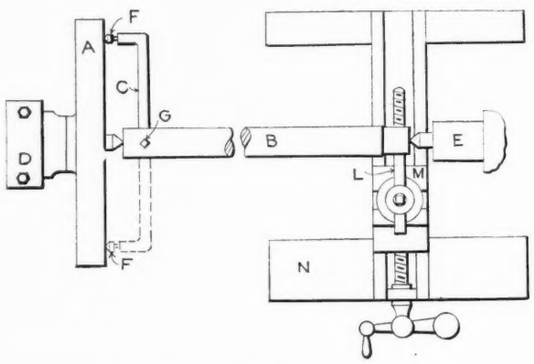


FIG. 2.

Having tested the live center, and leaving it in a position of truth, we are ready to try the tail-spindle E. With the turned end of the bar B next to the face-plate, adjust the cross-slide so that the tissue paper is lightly held between the bar and the end of L. Without disturbing the adjustment of the cross-slide move the carriage to the tail-stock end of the lathe, as shown in Fig. 2, and reverse the position of the bar B on the centers, but do not screw the tail-spindle up until the tissue paper has been inserted between the bar and the end of L. If the tissue paper pulls from between the two with the same resistance in both cases, the lateral adjustment is correct for that position. Now loosen the tail-stock and slide it along for a distance equal to the maximum movement of the tail-spindle in the tail-stock and try the new position in the same manner. If there be no change, the alignment and position of the tail-spindle is correct. The same method may be pursued in correcting the vertical alignment, only the part L should be of such shape as will enable the end to come above the bar B. Precautions must be taken in all cases to have the tail-spindle screwed up with the same degree of pressure, which should be just sufficient to prevent shake on the centers.

Having tested the alignment of the tail-stock, the truth of the head spindle may be tried for parallelism with the axis of the lathe. With the apparatus in the position shown in Fig. 1 the screw F is adjusted towards the face-plate until the tissue paper is lightly held between the two. Now turn the face-plate

and the bar B one-half rotation and then try the paper. If it be held tighter or looser, it shows the axis of the spindle to be out of parallel with that of the lathe. If the paper be loosest on the side next to the operator, it shows that the axis of the spindle has the position shown exaggerated in Fig. 1 by the line J K. H I being the axis of the bed. To correct this fault it will be necessary to set the boxes at the face-plate end of spindle over until the axis of the spindle coincides with that of the lathe. It will then be necessary to readjust the tail-spindle alignment.

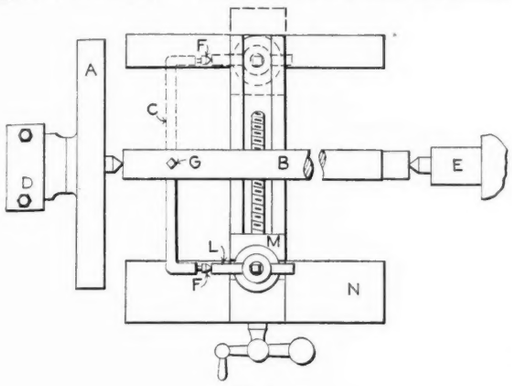


FIG. 3.

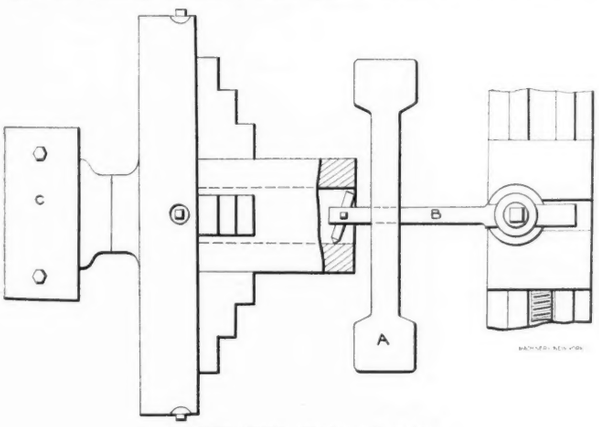
After the correct alignment of the head- and tail-spindle is obtained the cross-slide may be tested for its right-angle position. With the cross-slide in the position shown in Fig. 3 and the bar B with the angle-piece turned as shown adjust the tissue paper between F and L, then, without moving the carriage, run the cross-slide M over and turn the bar until the end F again abuts against L as shown by the dotted lines. If the tissue paper be held with the same degree of resistance in this position, the cross-slide is at right angles with the spindle and will face work to a plane surface. A lathe adjusted in this manner should face work to a plane surface, bore a hole of uniform diameter and turn straight within reasonable limits. NEMO.

* * *

SOMETHING MORE ABOUT SHAPER SLIDES.

Editor MACHINERY:

I noticed a letter in the October issue of MACHINERY which commented on the form of shaper slide suggested by the writer in the September issue, but apparently Mr. Gray does not think the scheme to be very feasible, as he works in an idea of his own, which is supposedly superior. As every one has a right to his opinions, I cannot quarrel with him, but as some of my friends have expressed their surprise at what they are pleased to call a freak design, I have felt called on to



ILLUSTRATING SPRING OF TOOL.

offer another argument which is thought will put the idea in a clearer light. As those who read the letter will remember, the argument was advanced that a certain amount of spring was unavoidable in any feasible form of shaper ram, and in view of this fact, a form was suggested which would make the defection uniform. The great objection appears to be with those who criticise the arrangement, is that it weakens the support of the ram when working short and close to the frame. The force of this objection is admitted, and attention was called to it in the original letter, but the writer considers the benefits to be derived to more than offset any disadvantages.

A good engine lathe under ordinary circumstances will bore a hole that will not vary from parallel over one-half thousandth of an inch in a distance of six inches, and, in fact, this error would probably condemn the tool on very close work. The boring tool is held in the tool-post at a distance from the point that will approximate eight inches, and the spring of the tool even under the most favorable circumstances is many times the allowable error. In homogeneous material, however, the amount of spring is uniform, which gives a uniform result in the hole being bored. Suppose, however, that some machinist has noticed the springing of the boring-tool, and in endeavoring to correct the fault he devises the steady-rest shown in the accompanying sketch, in which (A) is the steady-rest bolted to the lathe-bed and having a hole bored for the shank of the tool (B) which is thus solidly held to the work when starting the cut. It does not need any prophet to tell what the inevitable result must be, as the further the tool progresses on its way, the greater the amount of deflection, so the hole bored can by no possibility be parallel. It seems to the writer that the conditions met by the shaper ram are exactly the same, and that the only way to overcome the evil is to accept the logical solution, which is to make the deflection uniform at all points of the stroke.

Newark, N. J. F. EMERSON.

* * *

FAULTS IN SHAPER DESIGNS.

Editor MACHINERY:

Nearly all modern shaper designs are such that they cannot truthfully be called tools for doing accurate work, but their popularity is partly due to their ready adaptability to many kinds of work, and mainly to the fact that most of the work done on them does not require accuracy.

The pillar style is the most inaccurate of all designs, and no matter what shape or how heavy are the ram and guides a long piece cannot be planed straight, from the simple fact that the fit in the guides must be at least free enough to allow oil to flow between the surfaces and the long overhang of the ram multiplies the effect of the free fit. Furthermore, on account of unequal wear the guides become curved, and it is then impossible to plane anything straight.

As if that were not enough, the table is also another source of serious error. The table saddle is always shorter than the rail and is used most in the center, so that the table soon wears and sags more at the middle of the rail than near the ends. The table support is radically wrong, because the weight of the table and all on it overhangs, and the pressure of the tool cut crowns the whole. Of course all these faults of design have been recognized, and some notable attempts have been made to avoid them.

Without departing from the pillar style, the most heroic effort was made by the Fox Machine Company, who adopted the milling machine style of table, which almost eliminates the evil effects of wear and overhang of table. Their design of ram and guides, while an improvement on the usual style, is not a complete remedy for its evils.

The design, however, shows throughout marked evidence of a full recognition of the faults of the ordinary designs, and is an intelligent and praiseworthy attempt to overcome them. To remedy somewhat the evil of the overhanging table, some makers use a sliding prop under its outer end; but this is a nuisance, because it must be adjusted every time the table is raised or lowered and it is also about in the worst possible place a sliding bearing could be placed if it is to be kept clean and in good working order. The fact is that such a device is a confession that the table needs a radical change of design.

The traversing head style of shaper has a better kind of table, because the table-supporting guides are not subject to any serious wear, but the ram-mounting is worse than that of the pillar style on account of the additional sliding joint of the traversing head.

The most radical design and the one which approaches nearest the conditions required for accurate work is the Richards style. In this design there is but one feature which causes difficulty, and that is the feeding of the tool head along the rail, which is always changing its distance from the supporting and guiding ways, hence the tool always springs away from the cut

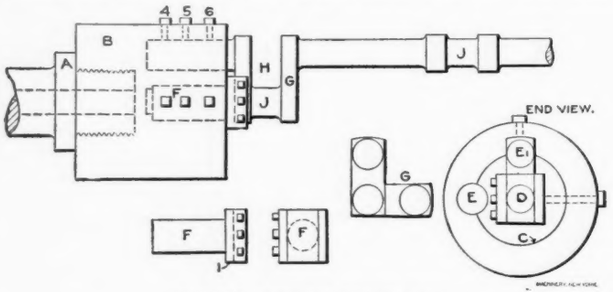
most of all when at the outer end of the rail. The table also springs the most when the tool is in the outer position. This design, however, embodies the right idea of tool-guide construction, and it can be modified so as to do very accurate work and maintain the shape of its wearing surfaces in a superior manner. The sole function of the tool-guiding head should be to carry the tool in a straight line, doing away with the transverse rail feed and retaining only the vertical feed as on the pillar shaper. The table for it should be supported from the base of the frame on a broad horizontal surface and have a transverse feed. With such a design the spring of the tool-carrying head would be a constant amount, no matter what the length of stroke or position of the object being planed. A good point in this design is that the wear on the guides which carry the tool-head could be readily equalized by choosing different locations of the table when the work permitted. Conceding the superior accuracy of such a shaper, the practical question is whether any one would buy it if it were offered. It would undoubtedly cost more to build than the regular kind, and, of course, no one would buy it at a higher price unless a more accurate machine was needed. It would cost less than a small planer, be equally accurate and more convenient to operate. That there would be some demand for such a tool is evidenced by the attempts to improve the regular style. Owing to the cost and the radical departure from standard designs, it would not sell without considerable persuasion, but if once introduced in a shop it would be sure to rank high in competition with other kinds. BELL CRANK.

* * *

TURNING CRANK SHAFTS.

Editor MACHINERY:

Enclosed find sketch of a jig used at the Mare Island Navy Yard for turning plain crank shafts for steam launches (A) is the end of the lathe spindle, on which is nicely fitted the casting (B); (B) is turned and faced and on its end is struck the circle (C) which represents the throw of the crank. The hole (D) is bored exactly 2 inches in diameter and as deep as required. The piece (B) is then carefully chucked and the holes (E) and (E_1) are bored respectively 2 inches in diameter and slightly over 2 inches with their centers at right angles and of a proper depth. Two inches is the finished size of shaft, and it is first turned to within 1-16 of finished size. The crank arms (G) are then planed to size and at exactly right angles with the shaft. The space (H) is machined out roughly. Into the hole (D) is nicely fitted the piece (F) which has a square end; this end is planed out in the center down to the dotted lines (I) and made to fit the crank arms. The crank shaft is put into the lathe and fitted to the hole (E_1), which is larger than the size finished of the shaft. The casting (B) is screwed on the mandril, the piece (F) put in place and the end of the shaft inserted in the hole (E_1) with the crank arms



RIG FOR TURNING CRANK PINS.

in the slot of piece (F). When this is done, all the set screws are set up and the wrist (J) is turned down near the size. The shaft being reversed and both ends roughed, it is again put into the centers and finished to size, which makes a fit for hole (E) and the casting (B) comes in again for finishing the crank. The back center is not used in turning the crank. This jig does good work and when a number of crank shafts are to be turned it saves a great deal of time and makes them all alike.

The jig was designed by Mr. W. G. Luper who had charge of the launch engine work. There were a number of launch crank shafts made in the same shop that reflected a great deal of credit on those concerned. The flange coupling on the end of the shaft, two thrust collars, two pairs of forward and back eccentrics (compound engine) and two cranks and air-pump eccentric were all forged in place; the finished size over all being only 26½ inches long.

The ends of the shaft were turned up on the centers and a disk, with all the centers required, fitted to either end. It was a tedious job, requiring a great deal of skill, but Mr. Bruner, the lathe man, did the work right. When the shafts were put in place there was no bother in finding some way to move the different eccentrics one way or the other in order to make the valves divide up in the proper manner. W. DE SANNO.

Kern City, Cal.

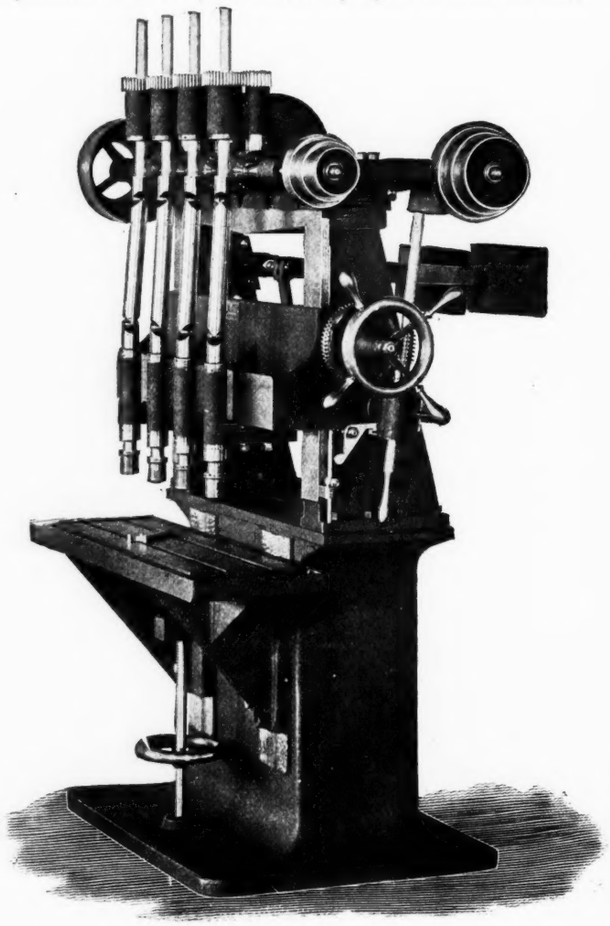
* * *

The ability to harden copper is thought by some to be one of the "lost arts," but it is more probable that instead of hardening the metal the ancients mixed with it a quantity of tin which made it hard and tough enough for their purpose.

* * *

FOUR-SPINDLE DRILL PRESS.

The accompanying illustration shows a new four-spindle drill press that is now manufactured by Foote, Burt & Co., Cleveland, Ohio. A new feature of the machine is the in-and-out adjustment of the drill spindles, in addition to the longitudinal adjustments. This makes it possible to drill four holes at one setting, in either a straight line or staggered, with any spacing from 2½ inches to 36 inches, center distance. The in-or-out adjustment is 2 inches, and almost any layout of holes can there-



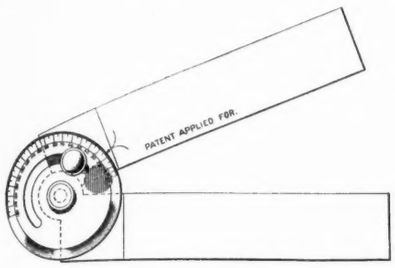
MULTIPLE SPINDLE DRILL PRESS.

fore be drilled with this machine. It is provided with power, cross-feed and automatic knock-off, and has three changes of feed and spindle speeds. Quick returns for the spindles are also provided.

The table is adjustable on the column vertically, so as to take various thicknesses of work under the spindles. The spindles are driven by steel bevel wheels having planed teeth, and are geared in the ratio of one to two of driving shaft. The machine will drive four three-quarter inch drills in steel. The table has T-slots and an oil groove around the edge, so that oil can be freely used. Similar machines are also made by this company with from two to ten spindles.

DRAUGHTSMEN'S ANGLE INDICATOR.

A useful and novel tool for draughtsmen is shown below, which is made by the Ashland Tool Works, Ashland, Pa. It is an angle indicator, consisting of two swivelling blades attached at their swivelling points to a German silver protractor, by which the blades can be set at any angle desired and locked in position. The instrument can be used as a triangle in connection with the T-square or as a protractor. It is also exceedingly convenient when parallel lines are to be drawn at any other than the standard angles, as, for example, in drawing screw threads. The instrument is said by the makers to be accurately made, and the cost is low. As usually made, the blades are of celluloid, one inch wide and five inches long. They are also made of nickel-plated steel, with level attachment, for mechanics' use, if desired, and make a convenient tool for the shop.



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FRANKLIN INSTITUTE ANNIVERSARY.

The Franklin Institute, Philadelphia, Pa., reached its seventy-fifth anniversary last spring, but its celebration of the event was deferred until the time of the Export Exposition, which is now being held at that city. The first of the meetings took place on Monday night, October 2, when the chemical section of the Institute opened the exercises with an introductory address by Dr. Joseph W. Richards, the president of the chemical section, who thus outlined the policy of the Institute:

He said that chemical science has always been prominently represented in the Institute's membership. The organizer of the Institute, Samuel Vaughan Merrick, was himself a practical mechanician, but had as his co-worker William H. Keating, professor of chemistry in the University of Pennsylvania, and they sent out the call for the preliminary meeting. Thus mechanics and chemistry conjointly presided at the birth of the Institute, fittingly typical of its future sphere of activity.

Professor Keating was appointed Professor of Chemistry as soon as the Institute was organized. At the annual meeting it was decided to form a section to which all chemical questions should be referred. This principle of the subdivision of the Institute was so fruitful of results that the example has been followed by the organization of four other sections. The creation of each was a distinct gain of activity to the Institute, stimulating individual effort in the direction thus specialized, and reacting healthily on the other membership by the general increase of interest in the Institute's work.

The Institute which so worthily bears the name of Franklin has always stood for the happy combination of theory and practice; the union of pure and applied science.

On Thursday evening, at the session of the mechanical section, Dr. Coleman Sellers gave an interesting address upon "The Progress of the Mechanic Arts in Three-quarters of a Century."

He said that his own lifetime was exactly coincident with that of the locomotive. Previous to the starting of the first railroad in England in 1827, which marked such an era in the commerce of the world (it had been in use before in hauling ore and coal from the mines by horse traction), Oliver Evans in Philadelphia and others had clear perceptions as to the possibility of a steam traction engine. The locomotive was then created separately from the railroad, and it was the bringing of the two together, as foretold by Evans and others, that made the modern railroad all that is understood by rapid transit now.

The progress of the mechanical arts depends wholly upon the appliances that are making for reproducing machinery; so that the birth of the machine tool industry, wholly within the period which is being considered, was of the utmost importance as measuring the rate of progress that could be made.

Dr. Sellers told a number of anecdotes in the course of his remarks, among which were the two following, the first of which relates to early machine tool work:

He said that when the engine was built for pumping the water at Center Square, Philadelphia, before the Fairmount works were built, the Oliver Evans type of high-pressure engine was used. The cylinder was cast in New Jersey. The boring rod for boring out the cylinder was erected with cutters in it, with levers attached, so that men walking around could propel the cutting tools, and gradually force the rod down through the cylinder until it had been turned out approximately round. After that it had to be filed to a surface. Probably a month was consumed in boring the cylinder. Previous to that fire-engine cylinders had been built in Philadelphia bored out in a similar manner by hand-boring tools. There were no lathes at that time fit for that work, nor was the planing machine then in existence. That came when Dr. Sellers was nearly a grown man. He wished to emphasize the fact that from it sprung all the wonderful advance in machine tool art.

When Oliver Evans gave the makers the size of the boilers to run the Center Square engine—they were plain cylinder boilers—those in charge of the erection deemed that if the length he prescribed was just enough for the requirements it would be well to make them ten feet longer. So they built them ten feet longer, but the boilers would make no steam. Evans was in New York and they sent for him. He returned as speedily as he could by the coaches of that day, and told them they must cut off the ten feet. The fire would not extend far enough back to heat the additional length, and all the steam made on the front end was condensed in the back end. This anecdote shows the general ignorance of the principles of the steam engine at that day.

When the perfection of modern mechanical methods is considered, however, the results obtained in early days should excite our admiration. Fifty years ago the locomotive had a speed record of a mile a minute; the improvements since have been in schedule time and longer runs, rather than changes in the original machine. Skilled Morse telegraphers of to-day can do as rapid work with Morse's original machine.

* * *

FILLETS AND ROUND CORNERS ON CASTINGS.*

The molder who keeps his eyes open will notice quite a variety of materials worked into fillets on the various patterns he handles, especially if he works in a jobbing foundry. Wood, leather, lead, beeswax and putty comprise the kinds ordinarily used, and they each have their time and place, except the metallic one. A pattern being of wood has a fibrous nature, which will hold glue or any other adhesive substance, while lead has no affinity whatever for glue; so the only thing that can be employed is shellac or nails. I have used yards and yards of lead fillets, so can speak from experience, and I have seen old engine beds and their foundation boxes returned for repairs, where these fillets were fairly stripped away from the pattern; even the small bung-head wire nails used would not keep them anchored down.

Probably the finest fillet of all is made of wood, worked out of the solid pattern, having no feather edges whatever, but this is a very expensive kind, and can only be used on the finest jobs, so in every-day practice we have to add the fillet to the pattern as a separate part.

For fillets from 1" radius down to ⅛", leather is unquestionably the best and most practical material that can be used, and when properly applied will not peel up even with the hardest usage, and requires no nailing whatever, glue being the only agent employed. Those who condemn the leather fillet for patterns, probably do not understand the proper method of applying it. There is a sort of trick about it, to be sure, the key-note of success being hot water. Cover the back of fillet with thick glue, and place it quickly on the pattern, instantly drawing a round-ended slicking tool of proper radius along its surface, bearing down hard to exude any superfluous glue, and following this with a woolen cloth wet in very hot water, to remove all pressed out by the slicker. Repeat this until not a particle of glue squeezes by the edge of the fillet, then wipe with a dry cloth.

This is really not so much of an operation as it may seem from the description and many feet of these fillets can be applied in a very short space of time.

Where it is hard to bind the leather neatly around small curves, etc., just immerse it in hot water, taking it out instantly. This renders it perfectly pliable, but it means quick work, for

* From a paper by John M. Richardson, in the Journal of American Foundrymen's Association.

the thin edges will shrivel and harden at once if not immediately placed in position and burnished down, as previously described. A leather fillet put on properly, with strong glue, can only be removed when dry by main force, and will then come off with fibres of the wood adhering to it, and sometimes the leather itself will keep breaking, it takes so much force to make it let go. Light patterns are strengthened by them to such an extent that nails are frequently unnecessary.

Beeswax is all right for very small fillets, and for finishing out where leather ones come together at the top edge of a rib, when the curve is very small, and for many other places. The wax is prepared by being put in a cylinder, having holes of varying diameter in one end. This is warmed and the wax forced through a plunger, and then applied with a warm slicking tool of the right radius.

If used too cold the fillet will not adhere firmly to the wood. In fact, it is hard to lay wax fillets satisfactorily in a cold room, for both pattern and wax are chilled to commence with, and the heated iron bearing on the top surface of the fillet only makes it difficult to communicate the heat evenly enough through the whole mass to secure a firm contact with the wood, and after the pattern has seen constant use in the foundry, the wax will peel up badly; also it is not a desirable substance for a fillet if sunshine or heat of any kind strikes it to any extent.

Putty has always been used in great quantities in pattern making, and probably always will be, on account of its cheapness. Undoubtedly more feet of fillet can be applied in a given time with this substance, for a given amount, taking both the material and labor into consideration, than with anything else, but it is only adapted to cheap work, and not for standard patterns, as it is soft, easily dented, marred or bruised, besides imparting no element of strength to the work. In some places plaster of paris is added to it to increase its durability, but when this is done, it must be used immediately after mixing.

Black putty is also frequently used. This is nothing but common putty mixed with lampblack, and is employed only on cheap work, having but one coat of shellac, this being applied after the sand-papering, thus comparing in color with the blacking on the pattern, and saving a second coat.

When fillets are called for having a radius above 1", then they must be worked out of wood, and this should be done after gluing to the pattern, not before, in order to have the feather edge adhere as firmly to the work as possible. It is almost impossible not to have the edge curl away if cut out first, and then fastened to the pattern, even if the precaution is taken to have the angle of the fillet made slightly greater than that of the corner it fits, in order to cause a binding of the edges.

A mold of any considerable size can be made more safely, quickly and easily and with a minimum of labor, where these points have been considered in the design, and carefully followed out in the pattern, and with far more chances for a perfect casting, as the danger of cracks in shrinking has been eliminated.

I would go so far as to say that every edge of a pattern, except on surfaces to be machined later, should be rounded, even if the radius of curvature is so small on some light work, that it can be done entirely with sandpaper, and on brackets, ribs, heading, etc., it is much more satisfactory when one gets accustomed to it to have the edges terminate in a semi-circular section, rather than flat with the two corners somewhat rounded.

This rounding of outside surfaces is necessarily on the pattern itself, but there is something else frequently not on the pattern that is expected just as much to be on the casting, and that is, the fillets. How many molders can testify to getting patterns with a chalk mark all around every corner and rib, and this injunction in two words, "cut fillets," also marked in chalk somewhere on the surface. Once in a great while a case occurs where this is justifiable, but it should be rare. A molder does not profess to be a sculptor, and when he is forced to carve out fillets in the sand, who can blame him if, instead of being the radius of a circle they prove to be the hypothenuse of a right-angled triangle. Then, too, there are often places in the mold where it is very difficult to do this, without dropping sand down into parts where it is hard work to remove it, and the result will be an imperfect casting.

The fact of cores coming into the interior of a casting, and the places made by them being entirely out of sight, is sort of a "will-o'-the-wisp" to some, who imagine that fillets are unnecessary because they do not show. This is a great error. They are just as much needed here as elsewhere, to strengthen the casting, and to help resist shrinkage strains, and should be put in of a size proportional to the casting to which they belong, but need not be made excessively large, as they frequently are on the outside of a pattern simply for the graceful effect, for these are not seen. Their place is in the core box, and not as a production of the coremaker's trowel or file. It will sometimes happen that a fillet is called for, on what is the top, or open end of a core box, thus making it impracticable for the pattern maker to provide for it. In such cases the core maker ought not to object to making it in the sand, and, as it comes within the casting, and is out of sight, a plain, flat damper is all that is required, and the fillets already in the core box will be a guide for the size. Another case showing the utility of heavily rounded outlines and fillets on castings is when they undergo the cleaning process, and they will also pickle and peel more freely, as there are no sharp corners for the sand to stick into, and thus time, and the edges of cold chisels, are saved.

As we reach the machine shop, the man who snags the casting finds no sharp corners full of sand to be scraped out with old files, and as he scours his work down with the coarse emery brick preparatory to painting, he can do much more effective service, for as the stone becomes rounded on the corners with use, it will still clean the large fillets, whereas with sharp corners it could not, and finally, when the iron filler is applied to one of these smoothly outlined castings, it can be sand-papered down easily and quickly, so that, after the painting is completed, the effect, when properly done, is almost like velvet.

LUCIAN SHARPE.

We learn with regret that the senior member of the firm of the Brown & Sharpe Manufacturing Co., Mr. Lucian Sharpe, died at sea while returning from a trip to Germany. The deceased was born March 20, 1830, and was therefore nearly seventy years old. He worked on his father's farm in his youth and received a common school education. Leaving the farm, he served a five years' apprenticeship with Joseph Brown and was admitted to a partnership in 1853. The firm of Brown & Sharpe was incorporated as the Brown & Sharpe Manufacturing Co. in 1868, and Mr. Sharpe has always been actively associated with the business end of the corporation rather than with the mechanical department. A widow, two sons and four daughters comprise the family which survives him.

Mr. Sharpe has left to those who come after him a business that has been conducted on principles of the strictest integrity and that furnishes employment to more than 1,800 men.

The employees at a meeting held Oct. 21 passed resolutions of respect and condolence for his family, and expressed the sense of their own loss in the following words:

"Whereas, Our respected employer and esteemed friend, Mr. Lucian Sharpe, has been removed from among us by death, we, his employees, desire to express our personal sense of loss, our appreciation of his character and our sympathy with his bereaved family.

"We have lost a just employer and a kind friend; this community a distinguished citizen, a wise counsellor, a true gentleman and an honest man.

"We appreciate the strength and nobility of his character, his kindly spirit, his scrupulous integrity and his profound common sense. In the management of his business he was himself as prompt and attentive to details as he would wish others to be, and his acts and influence tended to elevate his employees. His effort to express exact truth in every production will remain with us as a worthy example and perpetual inspiration.

"We extend our heartfelt sympathy to his bereaved family, and shall ever aim to show it by that faithfulness in our several positions which so thoroughly characterized him in all the relations of his life."

Oscar J. Beale.
Willard T. Hatch.
Alpheus L. Greene.
L. D. Burlingame.
D. D. Donovan.

PIPE BENDING.

R. H. PERRY.

The iron piping of an ordinary steam plant does not usually afford many examples of turns and offsets made by long bends in the pipe, but changes in direction are almost invariably effected by the use of pipe fittings of the required angles. The reason for this state of affairs is not difficult to understand, for, although it is generally understood that the less abrupt the change in direction of the flow of any medium, the less the losses from friction, yet the difficulty in making satisfactory bends in pipe much larger than 1½ inches is generally enough to discourage any refinements of this description. The piping of railway rolling stock, however, is subjected to such severe usage that every expedient is adopted in the best practice that will reduce leakage and maintain the integrity of the pipe lines, especially in the train pipes for the air brakes.

The consequence is that pipe fittings for changing the direction of any pipe, either on the locomotives or cars, are avoided whenever it is possible to bend the pipes and get them into position when bent. Many of the pipes on a locomotive are therefore so crooked that they will scarcely lie still when laid on the floor, and to be obliged to duplicate such an example of pipe bending is enough to strike terror to the heart of a pipe-fitter not accustomed to such work.

The proper bending of the larger sizes of pipe is a distinct branch of pipe-fitting which is rapidly coming to the front, especially in plants that are making extensive installations of pneumatic tools, as it has been found that the losses that occur in pipe lines put up in the usual slipshod manner are enough to warrant the extra expense of long bends instead of the ordinary fittings. It is thought that in view of these conditions a few pointers calculated to assist in making difficult bends will be appreciated by those likely to encounter work of such description.

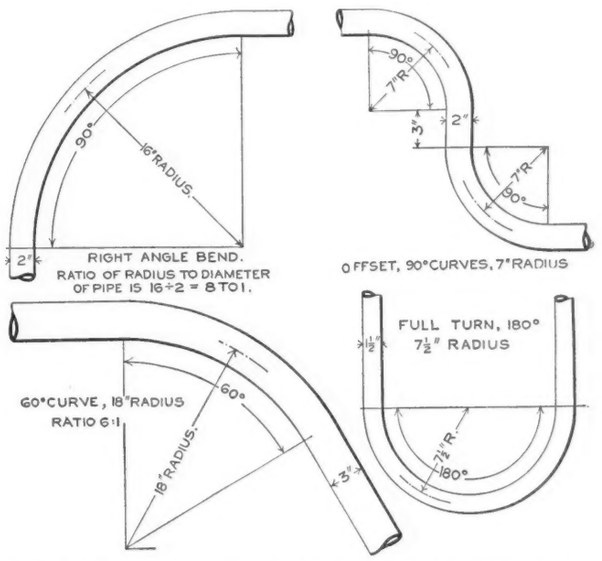
Of course, where large numbers of pipes are to be bent to the same radius it pays to expend considerable time and money on formers and apparatus for the work, but where the pipes are bent for a special job and to a variety of radii, it does not usually pay to prepare anything of the sort; so in the following it will be assumed that nothing is provided for the work that will not be found in any ordinary shop.

The most practicable method under such circumstances is to fill the pipe to be bent with perfectly dry sand and plug or cap the ends so that the filling will be retained under quite severe handling. Care should be taken to have the pipe well filled with the sand and that there is nothing inflammable or damp in it, as the necessary heating of large pipes is very likely to cause a serious explosion. The heating of the pipe may be done in an ordinary forge, and should be restricted to the part of the pipe that is required for the bend; also overheating should be avoided, as the loss from scaling has a very appreciable effect on the bursting strength. The best results will be obtained when the heat is not carried above a full red, as the liability to kinking is less, and in any case it is usually necessary to heat two or three times before a sharp bend can be satisfactorily made, so that nothing is gained by heating to a high temperature. A can of water should be provided, which should have a spout so that a small stream can be directed exactly where needed, as its proper use plays an important part in securing bends without kinks, a point which is highly desirable, as a kink is always an eyesore in the appearance of a pipe, besides seriously reducing its capacity at that point.

After the pipe has been heated to the proper temperature, it is clamped in the vise as close to the location of the bend as possible without grasping the red hot part and the bend started, but first the outside of the curve should be cooled with water carefully applied from the can. The inside of the bend being hot and plastic is compressed as the bend is made with very little tendency towards flattening, but if such a tendency develops, it can be corrected by loosening the pipe and using the jaws of the vise to bring the flattened part back to an approximately circular section. The reason for applying the water to the outside of the curve is that by forcing the bend to take place on the inside of the curve, the pipe walls are better supported by the filling, for the reason that the cubic contents are slightly reduced by the compression; whereas if the exterior of the curve be allowed to stretch, the cubic contents are slightly increased, which allows a small amount of slackness in the filling at that point and a consequent lack of support to the interior of the pipe. The use of water also plays an important part in the proper formation of the curve, as by its use the pipe may be cooled at a point where the required curvature has been obtained and still leave the remainder in a condition to be bent as desired. When bending pipe without formers it is necessary to have a template, which may be made from a ¼-inch rod bent to the desired curve and which, being laid on the pipe while bending, gives a guide for the operator. The use of water for cooling the outside of the curve can usually be dispensed with when the radius equals or exceeds fifteen times the diameter of the pipe.

When bending the cheaper grades of butt-welded iron pipe care should be taken that the seam comes on the inside or the outside of the curve and not on the sides, as it is much more likely to crack open in the latter position. While considerable experience is required before the best results can be obtained in hot pipe bending, the method to be pursued is simple when it is understood—a condition which, however, is equally true of many other things.

When piping or thin tubing is to be bent and it is necessary to avoid heating on account of the finish or other reasons, it is customary to use a filling that can be melted at a low temperature, such as rosin for copper or a metal alloy for iron or steel pipes. As these alloys are made that will fuse at or slightly above the boiling point of water, their use is feasible on small pipes, but scarcely so on the larger ones, as the immense amount of metal required, together with the inevitable losses from melting and filling, is a serious expense.



SOME SAMPLES OF PIPE BENDING SHOWING THE RELATION OF THE DIAMETER TO THE RADIUS.

A simpler method which has been recommended for cold bending is the use of a coil of closely wound steel wire of a diameter slightly smaller than the interior of the pipe to be bent. Good results are obtained where the curves are of a moderately long radius and where the bend is not of sufficient angularity to prevent the removal of the coil after the bend has been made. This difficulty can be helped by tapering the coil to which the chain or cord is attached to a smaller diameter than the main part, so that when the tension is applied the turns of wire successively reduce in size until the whole coil can be removed. The use of bends in piping will usually necessitate the use of unions or right and left couplings, both of which are somewhat more likely to leak than the ordinary right-hand coupling, but when properly put together there should be no trouble in this direction, and, besides, such a construction possesses an advantage in being much easier taken down for repairs or change than the ordinary system.

The time is, therefore, not far distant, let us trust, when the piping of our modern plants will be characterized by the absence of unnecessry right-angle pipe fittings and the presence of graceful curves that satisfy both the eye and the instincts of the mechanical engineer.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

10.—M. P. B.: I have seen a man set the tail stock of his lathe over and turn a piece taper at one trial, without any filing, so that it would fit a taper hole. Please tell me how to set over the center so as to do this.

A.—We think, in the first place, that if your friend had rubbed a thin coating of Prussian blue on the taper piece and then fitted the two together he would have found by noting where the blue had rubbed off that he did not have a close fit the whole length; or, if he did, it could have been only by chance, for, unless some very unusual precautions are taken, such as would not be used in every-day work, it is not possible to obtain so accurate a taper by setting over the head stock without one

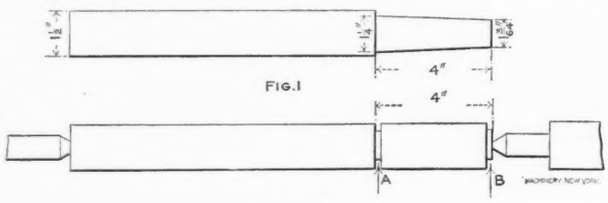


FIG. 2.

or two trials. In turning tapers it is best to determine before starting what the large and small diameters of the taper are to be. Suppose, for example, that you have to turn a Morse taper shank on a piece like Fig. 1. We know that the Morse taper is about ⅝ inch per foot—that is, a taper piece 1 foot long would be about ⅝ inch larger in diameter at one end than at the other end. Suppose you have a socket to fit the taper to and that you find it is 4 inches long and that the mouth of the socket measures about 1.25 inches. Since the taper is ⅝ inch per foot, the taper in 4 inches would be $4\text{-}12 \times \frac{5}{8} = 1\text{-}3 \times .625 = .2$ inch, and this subtracted from 1.25 inches, the large diameter, gives 1.05 inches, or about 1 3-64 inches as the small diameter. Now center and lay out the piece, put it in the lathe and scribe a mark 4 inches from one end. With a cutting-off tool neck in at A until it calipers 1-32 inch over 1¼ inches and turn down at B until it calipers the same amount larger than the small diameter, or 1 5-64 inches. Finally, put a pointer in the tool post and set over the tail stock until the pointer will just touch at A and B, the work being removed from the centers and the carriage moved along to so as not to disturb the pointer when changing its position from A to B. When turning the taper set the tool exactly on a level with the centers. Rough out the piece and try it in the socket. This will show how near you have hit the taper, and with one or two trials you should be able to finish the piece.

11.—A. C. H.: Please tell me what book you think would be the most useful for a man wanting information about gas engines and their design.

A.—The series of articles upon the gas engine, commencing in this issue of the paper, will cover gas-engine design in a simple and comprehensive manner. The work by D. Clerk, "The Gas and Oil Engine," published by John Wiley & Sons, New York, is generally regarded as the most complete general treatise upon the gas engine. The price is $4. Another good book, though a smaller one, is "Modern Gas and Oil Engines," by Grover, for sale by D. Van Nostrand; price, $2. This book contains a chapter upon the design of gas engines, with the necessary calculations worked out. If one wishes a description of many different types of engines merely, with only a brief explanation of the theory, "Gas, Gasoline and Oil Engines," by Hiscox, published by Norman W. Henley (price, $2.50), may prove serviceable.

12.—A. H.: 1. What size engine would be required to run a boat 40 feet long, 7 feet beam, of a good model, 12 knots an hour? 2. What should be the proportions for a compound engine for such a boat, revolutions 225 and boiler pressure 300 pounds? 3. What is the best make of boiler to use? 4. What would be the best form of propeller? 5. Please give me the names of manufacturers of castings for such an engine.

A.—1. Assuming that the draught of your boat is about 2 feet, it would require 45 horse-power. If you were content to attain a speed of 10 knots, 25 horse-power would answer. 2. We do not like the pressure and number of revolutions that you propose to use. A boiler pressure of 300 pounds will give a very high mean effective pressure in the cylinder, meaning that cylinders of small diameters can be used. On the other hand, the number of revolutions is not high enough to give a piston speed of 700 or 800 feet per minute, as it should for best economy, without making the length of cylinder entirely out of proportion to its diameter. We would suggest that you adopt 150 pounds pressure, and increase the number of revolutions to 400. There is no economy in such high pressures for small engines. When you decide definitely upon these points we shall be happy to help you with the proportions of the engine; or, better, can refer you to "Compound Engines," by James Tribe, Racine, Wis. (price, $1.50), from which book you can learn to make your own calculations. 3. The Almy water tube boiler, made at Providence, R. I., is one of the best. 4. Use a four-bladed propeller. Read the article upon "Steam Power of Small Yachts" in the April number of this paper. It was written to hit just such cases as yours. 5. We think there are no castings made that are for sale as large as you will require.

13.—Apprentice: 1. As I understand it, it is because of the presence of carbon that tool steel hardens on being immersed in water after being heated. Why does not machine steel, which possesses some carbon, harden on being heated and cooled? 2. Also, why does not cast iron harden, since it possesses quite a percentage of carbon in combination? 3. Every blacksmith knows that steel, if overheated, will "burn" and become useless. How is it possible, then, to melt steel in the open air and run it into molds, to be called cast steel?

A.—1. You are quite right in your supposition about the effect of carbon in steel. Just why this is so we cannot tell, and we are not sure that chemists are fully agreed upon the subject either. Experience shows that steel with .25 per cent. of carbon will toughen somewhat when heated and immersed in water. Below this point the effect is not noticeable, and, as machine steels seldom are as high in carbon as this, they will not harden. 2. The ordinary gray cast iron contains a large percentage of carbon, usually 3 or 4 per cent.; but only a very small proportion of this is combined. One analysis which we have shows only .04 per cent. of combined carbon, which disposes of the question of hardening, so far as gray iron is concerned. White cast iron, on the other hand, contains nearly all of its carbon combined, and, as you know, it is often very hard. Chilled iron is essentially hardened iron, and is often hard enough so that it is used for cutting tools. In order to harden, or chill, it, however, it must first be heated to a temperature high enough to melt it, in which respect it differs from steel. 3. When a blacksmith "burns" steel, he partially melts the steel, and the heat of his fire is so intense that the steel becomes decarbonized to a greater or less extent. This is exactly what would happen when cast steel is made, were it not for the fact that the metal is heated with ores which contain sufficient carbon to make the final mixture of the molten metal have just the proportion of carbon desired.

14.—B. E. S.: 1. Please tell me the proper way to grind drills for brass, iron and steel. 2. Should the countershaft of a lathe be placed directly over it or at the back, and if the latter, is 45 or 30 degrees the proper angle? Also, how far above the lathe should the countershaft be placed?

A.—1. In grinding drills the two lips should be of the same angle and length, as otherwise the drill will crowd to one side. The angle of lip clearance should be greater at the center than at the ends of the lips, but it must not be excessive, as it will cause the drill to "bite." The angle of the lip to the axis of the drill should be 60 degrees, as this angle will give a straight cutting edge. We should grind the same for iron or steel, but for brass or other soft metals you may have better results if the lips of the drill are flattened from 1-32 to 1-16 of an inch in a plane parallel to the axis of the drill. This prevents the drill from catching when breaking through at the bottom of the hole. The Standard Tool Company, Cleveland, Ohio, makes a neat twist drill gauge that is of assistance in grinding drills. 2. The countershaft should be placed slightly back of the lathe, and we should prefer at an angle not to exceed 30 degrees. For a shaft of ordinary height the countershaft should be placed per-

haps two feet back of the lathe. While an inclined belt of considerable length has greater driving power than a short vertical one, the chief point to consider in putting up countershafts is the convenience of the workman in shifting his belts, provided there is nothing to make it necessary to place the countershafts elsewhere. If you have unlimited head room, we should place the countershafts at as great a height as you find upon experiment you can easily shift the belt from one step of the cone to the next one.

15.—A. W. P.: 1. Please give me the taper for lathe spindle bearings as usually considered the best practice in the United States. 2. What do you consider to be suitable speeds for metal working?

A.—1. It is not the usual practice, nor is it considered the best practice, in this country to taper the spindle bearings of lathes. The best we could do, therefore, would be to refer you to proportions given in English works upon machine design, which you probably already have at your disposal for reference. 2. The following cutting speeds probably represent average practice: Cast iron, 20 to 30 feet per minute; wrought iron, 25 to 30 feet; machine steel, 25 to 35 feet; tool steel, 12 to 15 feet. These figures may often be widely departed from, however. Cast iron may be so hard that it is almost impossible to cut it at all, and, on the other hand, if particular attention be paid to its composition in the foundry, it may be soft enough to cut at a very high rate of speed. In shops in this country where this is done it is quite common to cut cast iron at the rate of 40 feet per minute. Again, the same things are true of steel. High carbon steel may have to be cut at a very low rate, and we have known of soft machinery steel being cut at the rate of 100 feet per minute. The speed must necessarily depend, also, upon the size of cut taken and whether the tool is flooded with oil or soda water, as is done in many shops, and always on screw machines, where a cutting rate of 40 or 50 feet is not uncommon.

16.—C. G. P.: Please inform me whether a cemented or a laced joint is the better for belts, and which is the stronger and how much stronger. 2. What is the best way to make a cemented joint?

A.—1. Barring the fact that it is not easy to take up the slack in a cemented belt, such a belt is better than the laced one. A good cemented joint should have nearly or quite the full strength of the belt. It would be safe to consider a laced joint as having one-third the strength of a cemented one. To make a cemented joint a belt clamp must be used to hold the ends in position. Shave off the ends on a bevel to a distance of about one and a half times the width of the belt, shaving the leather from the inside of one end and the outside of the other. Now coat the surfaces thoroughly with fish glue and clamp together. To hold firmly in position, peg together with a few shoemaker's wooden pegs. A good deal of skill is required to make a solid joint, and it will not have the desired strength, of course, unless it is well done. From some dealer in belting you may be able to procure a water-proof cement if desired.

* * *

We are constantly being reminded of the wonderful things that are accomplished by the aid of electricity, as for example, the following item, clipped from a recent issue of an electrical paper, will show:

"Sculptors are now said to be doing much of the mechanical part of their craft by means of an electrical carver. The actuating power of the device is derived from a small electric motor and pump, which, standing on the scaffold, supply air at a pressure of fifty pounds to the square inch. In his right hand the carver holds a steel cylinder, to which the compressed air is conveyed by rubber tubes; the other hand holds the chisel, which fits loosely into a socket at the end of the cylinder. Within the barrel of the cylinder is a solid piece of steel with hardened, bullet-shaped head. Under the pressure of the air this strikes the end of the chisel, rebounding and restriking with a varying rapidity of from 4,000 to 5,000 blows a minute."

It must require quite a stretch of imagination to be able to designate a compressed air appliance as an electrical tool, simply on account of the air supply being furnished by an electric motor. It would be equally as sensible to call the sculptor's tool a hydraulic carver if it should occur that the compressed air were supplied by a water motor.

The Dewey celebration in New York City was, of course, immensely profitable for the local traction companies, and all of them broke their previous records of numbers carried. The "Electrical Review" is responsible for the following figures, which, if they could be grasped, would give somewhat of an idea of the magnitude of the crowds that came to welcome the victorious Admiral: "On September 28 the Metropolitan Street Railway Company carried 1,119,000 cash passengers, or 215,000 more passengers than the system had ever before handled in one day. On the following day it handled 1,304,380 persons, and on Saturday 1,019,440. On October 1 the road carried 711,480 people. On the Third avenue line the increase of passenger traffic for September 28, 29 and 30 was 572,000. The receipts of the Brooklyn Rapid Transit Company for September 29 and 30 were close to $75,000.

* * *

FRESH FROM THE PRESS.

Heat and Heat Engines, by Frederick Remsen Hutton, E. M., Ph.D., Professor of Mechanical Engineering, Columbia University. Published by John Wiley & Son, New York. 540 8vo pages, illustrated.

This book gives a practical treatment of a theoretical subject and will prove a useful handbook for the engineer in practice. It tells in a clear manner how to make the calculations most often met with in connection with the different forms of apparatus that depend upon heat for their action. It is essentially a treatise on thermodynamics, although broader in its scope than this term implies, and it differs from other works in that the higher mathematics are not used. The book is not in any sense an elementary work, but the author asks the reader to accept the results deduced by the higher mathematics and then shows how they are applied in practice. It is believed that the student will secure a firmer grasp of the subject when he is able to get at the practical applications from the start than where he is compelled to first plow through intricate mathematical demonstrations, the utility of which he cannot at once appreciate. The book contains the material that is given the students in mechanical engineering at Columbia University in connection with "The Mechanical Engineering of Power Plants" by the same author, which has previously been mentioned in these columns. It will also prove of use to men engaged in engineering work.

The various subjects follow in logical order from the generation of heat in the furnace to the design of the cylinder that is to utilize the heat energy of the steam or other heat medium. The chapters on fuel, pyrometers, draft and heating surface introduce subjects generally found only in books on steam boilers; but their grouping with the other subjects makes the work a complete reference book of the general principles underlying the generation of power from heat. Besides the steam engine, the air compressor and compressed air engine, the gas and oil engine, the vapor engine, refrigeration and the injector are given full treatments. The essential facts regarding gases and vapors are also discussed.

At the present time the books by Peabody and Ewing are perhaps the best known modern authorities upon the subjects mentioned above, but their treatment is so mathematical that the general reader would probably think them unavailable for his use. Prof. Hutton has prepared a work of the same grade and has done a real service by treating the subjects in such a manner that they can be readily approached without a knowledge of the calculus. After mastering its contents the student may then find his appetite sufficiently whetted to investigate the intricacies of other works.

We think it would have been appreciated if the author had added a chapter on the results of tests upon apparatus treated so that the student would have more definite information on which to build. It seems to be quite as essential to have this information in questions pertaining to heat as in the strength of materials.

ADVERTISING LITERATURE.

THE STANDARD SIZES FOR CATALOGS ARE 9 X 12, 6X9 AND 3½X6 INCHES. THE 6X9 IS RECOMMENDED, AS THIS SIZE IS MOST LIKELY TO BE PRESERVED.

Weston Manufacturing Co., Springfield, O.—Catalogue of lathe, planer, and shaper tools—18 6x9 pages illustrated.

A variety of tool holders are made by this company for boring, turning, threading, planing, etc., and the line which they have to offer appears to cover the field very thoroughly. A number of the holders are quite novel in design.

The D. Van Nostrand Co., Publishers, Murray street, N. Y., have now ready an eighty-page alphabetical and classified catalogue of electrical books. It is arranged by subjects and authors, and will be sent free upon application.

We have received from the Joseph Dixon Co., Jersey City, N. J., an interesting pamphlet setting forth the advantages of

flake graphite for use in steam engine cylinders, together with a description of the necessary appliances for introducing the graphite in the cylinder. We would suggest to engineers that they write for this pamphlet, as it will be of value to them.

Brown & Sharpe Manufacturing Co.—Catalogue of machinists' and measuring tools, 150 6x9 pages illustrated.

This is a new catalogue that will be of interest to machinists who are always anxious to keep informed upon new tools as they are put upon the market. There are new illustrations of the older tools which show them much more clearly than before and it has been the aim to give as complete and full information as possible throughout. Among the new tools that we note are some new styles of steel scales, micrometer calipers for measuring up to 6 inches, inside micrometers, a height gauge, a new surface gauge, and there is also shown a photographic reproduction of the Brown & Sharpe measuring machine which measures to point 00001.

The Standard Tool Co. have issued a small pocket manual of 24 pages that contains data of value to mechanics and also illustrates some of the tools made by this company.

The Safety Emery Wheel Co., Springfield, O.—Catalogue of emery wheels and grinding machinery, 80 6x9 pages illustrated.

A full line of emery wheels is listed in this catalogue all of which have an annular shoulder near the wheel over which a collar fits and thus prevents serious results in case the emery wheel bursts. A complete line of grinding and polishing machinery is shown and there are a number of technical points given in the catalogue for the uses of these appliances.

One of the handsomest and most elaborate catalogues that has been received at this office is one that is issued by W. S. Laycock, Sheffield, England. It relates to railway carriage fittings and steamship specialties and is illustrated with beautifully executed half-tone engravings.

MANUFACTURERS' NOTES.

The Standard Pneumatic Tool Co., Chicago, Ill., advise us that their mechanical superintendent, Mr. Henry Kimman, will superintend the installation of machinery in the works of the International Pneumatic Tool Co., Chippenham, England, which company recently purchased the right to manufacture and sell the Little Giant Pneumatic tools in the British Empire. He will later make a tour of inspection throughout Europe.

The Tanite Co., of Stroudsburg, Pa., is building a new and improved Emery Planer for the Altoona shops of the Pennsylvania Railroad Co. This machine will be the largest of the kind yet built, weighing in the neighborhood of a ton and a half.

The Trade Paper Advertising Agency will soon open a branch office in Philadelphia for the convenience of its clients in that district, which will be in charge of Mr. S. A. Elkington, who has recently become connected with this firm.

The Cling-Surface Co. send us the following copy of a letter received from Prof. Carpenter under date of October 5: "Later tests of the use of Cling-Surface on belting substantiate in every particular the statements made in my report of April 17. They also indicate higher efficiency of transmission and less loss of power in the case of belts treated with Cling-Surface than in the case of belts not so treated, when working under the conditions prevailing at the time of the earlier test. This is due to the fact that the slipping of a belt causes considerable loss of power, the power so lost passing off in heat. The use of Cling-Surface reduces the slipping and consequently reduces the loss of power occasioned by the use of belts that slip. During the past six months I have had occasion to observe the practical use of Cling-Surface in a number of instances. In all such cases Cling-Surface has improved the belts by softening them, and as far as I can determine in the limited time (seven months) tends to preserve the leather of which they are constructed."

Rawhide, fibre and hard rubber gears. THE ARTHUR CO. (See page 41.)

FOR SALE.—One of the best located jobbing foundry and machine shops in the Mississippi valley. Good trade established. Satisfactory reasons for selling. Address Box 554, Galesburg, Ill.

WANTED.—Second-handed wood, iron and bronze working machinery, first-class condition, at very low price cash. Can use complete factory outfits. Itemize and describe machinery for sale, giving condition, age, name and address of manufacturer, attachments, etc., and lowest price at which each machine will be sold. Address "MACHINERY," P. O. Box 528, Chicago, Ill.

FOR SALE.—Arthur Herschmann's Hydraulic Clutch. Manufactured under license in Austria by Messrs. Actiengesellschaft für Maschinenbau Brünn; in Great Britain by Messrs. Alldays & Onions, Limited, Birmingham.

Automatic and only positive acting clutch in which engaging and disengaging force are alike, the second being the reaction of the first. American patent will be issued October 24. For license or purchase of patent address,

Herschmann, care of MACHINERY, 9-15 Murray St., New York.

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Fresh from the Press 95

The New Gorton

Universal Disc Surface Grinding Machine

is now ready, and every one who uses such tools should at least examine it carefully and compare it with others. That's all we ask.

Geo. Gorton Machine Company,

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